Foreword

Evaluation is an integral part of any curriculum package Development of test items is, therefore, an important responsibility of the curriculum developer. With this in view, the Department of Education in Science and Mathematics (DESM) in the NCERT has undertaken the task of developing test items in different subjects. Under this project, the book *Test Items in Chemistry* for Class XI has already been published

The present publication *Test Items in Chemistry* for Class XII is in continuation of the test items for Class XI The draft material was developed in two workshops and has been finalised and edited by Prof. M Chandra The necessary guidance and support for the proper execution of the project was provided by Prof. B. Ganguly, and after his retirement, Prof. K V Rao, Head, DESM

We are thankful to the members of the chemistry team of the DESM and all the others who were associated with the preparation of this volume, which I hope will be of great use to the teachers and students of Class XII.

We would welcome suggestions for the improvement of this publication

DR K GOPALAN
Director
National Council of Educational
Research and Training

GANDHIJI'S TALISMAN

"I will give you a talisman.Whenever you are in doubt or when the self becomes too much with you, apply the following test :

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words,will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away."

MKGandhi

Contents

FOREWORD iii

Test Evaluation in Curriculum Development : A Few Thoughts vii

UNITS

1. *Structure of Atoms and Molecules* 1
2. *The Solid State* 9
3. *Solutions* 18
4. *Chemical Thermodynamics* 29
5. *Electrochemistry* 38
6. *Chemical Kinetics* 47
7. *Organic Chemistry Based on Functional Group I* 57
8. *Organic Chemistry Based on Functional Group II* 65
9. *Organic Chemistry Based on Functional Group III* 74
10. *Chemistry of Main Group Elements (s- and p-block Elements)* 81
11. *Transition Metals Including Lanthanides* 89
12. *Coordination Compounds and Organometallics* 95
13. *Nuclear Chemistry* 101
14. *Synthetic and Natural Polymers* 107
15. *Surface Chemistry* 113
16. *Biomolecules: Structure and Functions* 120
17. *Chemistry of Some Biological Processes* 126
18. *Chemistry in Action* 134

KEY 141

SOULUTIONS TO NUMERICAL PROBLEMS 186

LIST OF PARTICIPANTS 220

SCIENCE RELATED VALUES

Curiosity, quest for knowledge, objectivity, honesty and truthfulness, courage to question, systematic reasoning, acceptance after proof/verification, open-mindedness, search for perfection and team spirit are some of the basic values related to science. The processes of science, which help in searching the truth about nature and its phenomena are characterised by these values. Science aims at explaining things and events. Therefore to learn and practise science :

* **Be inquisitive about things and events around you.**
* **Have the courage to question beliefs and practices.**
* **Ask 'what', 'how' and 'why' and find your answers by critically observing, experimenting, consulting, discussing and reasoning.**
* **Record honestly your observations and experimental results in your laboratory or outside it.**
* **Repeat experiments carefully and systematically if required, but do not manipulate your results under any circumstance.**
* **Be guided by facts, reasons and logic. Do not be biased in one way or the other.**
* **Aspire to make new discoveries and inventions by sustained and dedicated work.**

Test Evaluation in Curriculum Development

*A Few Thoughts**

In 1956, a Committee of College and University examiners in the USA published *Taxonomy of Education Objectives* edited by Benjamin S. Bloom of the University of Chicago In this taxonomy, objectives for any specific subject were classified into three domains—cognitive, affective and psychomotor. These domains bear considerable resemblance to the broad categories of knowledge, skills, attitude and interest.

More specifically, the cognitive domain includes those objectives which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills It is this domain in which most of the work of curriculum development has taken place. The affective domain includes objectives which describe changes in interests and values, and the development of appreciations and adequate adjustments. Psychomotor domain includes objectives related to changes in manipulative and motor skills.

The objectives in the cognitive domain were further classified by Bloom in his Handbook I, into a detailed classification scheme with illustrative test questions Objectives involving recall only were referred to as "knowledge objectives", whereas the intellectual abilities and skills of organising and re-organising were split into 5 major classes: comprehension, application, analysis, synthesis and evaluation. The major classes were further sub-divided. Most education achievement tests are concerned with the cognitive domain.(1)

One of the important uses of the test-evaluation procedure is to help teachers make these education objectives more complete and clear. As these objectives become clearly defined, it is possible to make more realistic decision about their desirability and feasibility. Furthermore, as the objectives become increasingly specific and clear through the use of behavioural definitions and of operational definitions (i.e. actual test questions), it is possible for the teacher to begin to think of the kinds of learning experiences which are likely to help students grow in ways defined by the objectives. The teachers may also become more aware of the relevance or lack of relevance of these objectives of the learning experiences now available to students. Thus, the very process of thinking about test and evaluation can help teachers to classify their educational objectives and improve the quality of their instructions.

---

* By Prof M Chandra, DESM, NCERT, New Delhi

Another effect of the test-evaluation instrument is to motivate students and to direct the ways in which they study and prepare. Questions devised could also require the students to think about the significant problems in contemporary life Such questions may help students to find meaning and purpose in the study of the subject and help them to bridge the gap between the learning that goes on in the schools and the vital problem in the environment in which the students live. Thus, examinations are intricately interwoven with evaluation purposes and learning experiences, and it is impossible to consider one without the other. The development of the students is the goal of the learning process—the instructional material, the teaching methods and the testing procedure being all means for these ends.(2)

The evaluation and judgement of teachers and the action which flows from these assessments are of vital importance to students in the higher secondary stage. Continual evaluation of the student by teachers and peers through formal examination and by less formalized processes, provides one of the major sources of information by which a student develops 'self-concept' The test-evaluation process at this stage of schooling influences the teacher's behaviour as well. The thoughtful teacher uses this information as a guide to the teacher's own teaching practice : What has been grasped by the students? What needs revision? Who has failed to understand? The teacher's self-concept is, therefore, also being developed by the same test-evaluation procedure.(3)

Evaluation may reveal that certain curriculum objectives were not attained, and may suggest changed learning experiences or may even lead to the modification of objectives Accurate assessment of education outcome is thus essential for sound planning and effective stimulation of growth in our education structure. Testing and assessment have always been integral aspects of curriculum development, and should thus be major responsibilities of curriculum workers.

Types of Questions

Just a century ago, Horace Mann was influential in replacing oral examination, then in vogue, with written ones. He argued that many questions asked uniformly of all students were fairer than a smaller numbers that varied from student to student. Until a generation ago, written essay-type tests were almost universally used. During the 1920s and 1930s, however, essay questions were increasingly subjected to attack, largely on grounds of the subjectivity of their scoring and their failure to yield diagnostic results Too many irrelevancies were said to enter into the scoring process, and the final outcome was said to represent a blending of many diverse elements. The main recommended substitution was the so-called objective items. These kinds of questions were taken to eliminate variability in scoring, although they are said to retain other variable elements such as the effects of guessing and of daring on the part of the students. To this day, both essay (or extended answer questions as they are often termed now), and objective questions have their advocates, and many are prone to debate their respective merits. This debate represents an over-simplified view of the issues involved, since each approach to test and measurement has strengths and weaknesses.(4)

Similarly, controversies exist regarding the suitability of content-type and application-oriented questions. Although application-oriented questions are often advocated since they are said to eliminate tendencies of rote learning among students, but it is not that content-type of examinations have no validity whatsover—or that there is no legitimate place in tests for items that hold the students responsible only for recall, or for recognition of specific items of information The case for the continued use of tests of this type rests primarily on two considerations. (i) some of the content of instruction in any subject is taught with the hope that it will be permanently retained by the student, and (ii) even with content which is primarily of immediate instructional value only, there is some positive correlation between the students' ability to recall this content and the extent to which the student has derived any generalised values from it and will retain them permanently

Objective-type Tests

All *objective-type* test items are divided into two main classes the supply type and the selection type. In the supply-type test items, students respond by supplying the words, numbers or other symbols which constitute the response The short-answer type are often included in the supply type. Whereas, the true/false, the multiple choice and the matching-type questions represent the selection type—where students respond by selecting responses from among those presented in the item. Of course, both the extended answer-type and the objective-type questions can include numerical problems.

The *short-answer* form is often characterized by the presence of a blank on which the examinee writes the kind of answers called for by the direction, and can be of three basic varieties: the question variety, the completed variety, and the identification or association variety

The *true-false* form consists of a statement to be judged true or false, and is essentially a two-response item in which only one of the possible alternatives is explicitly stated, This type also contains the right-wrong variety, the yes-no variety, the correction variety, the cluster variety.

The *multiple-choice* form consists of: (i) the stem — or that part in which the task which the students have to undertake is set out together with any data which is necessary for the student to answer correctly; (ii) the response — which refers generally to four possible ways in which students may answer — the correct response being called the answer, and the incorrect responses the distractors A single multiple-choice item may possess the characteristics attributed to several distinct varieties such as. the best answer variety; the multiple response variety, the correct answer variety; the incomplete statement variety; the negative variety; and the combined response variety.

The *matching* form of objective test exercise consists of a list of premises, a list of responses and directions for matching one of the responses to each of the premises The two chief varieties of matching forms are the simple matching and that based on classification of statements.

The *pictorial form* of test items are based on pictures and graphical representation. These items are of two general types — those in which the picture itself presents a problem in interpretation, and those in which the picture serves as an effective means of communicating ideas

A Few Suggestions for Developing Test Items

To understand the principles of development of test items, one needs to consider the function of the different types of question items The extended answer-type questions test students' power of expressing coherently a trait of logical reasoning, their ability to choose the length of the answer, and their power of describing the kind of apparatus or the process involved. Tests with extended answer-type questions thus get a higher premium on the power of expression. But in times of pressure, or stress, some students frequently fail to do themselves justice and fail even to realize what is required of them. A little 'prompting' may make a difference in such cases. Objective tests may provide this prompting. The answer of one or two words can test knowledge of facts, answers of a line or two of writing can test power of generalization. Similarly, supply of missing words, selecting appropriate terms, or deleting the incorrect ones out of suggested alternatives which are special features of the objective-type questions can test application of knowledge and power of reasoning.

Every objective test item begins with an idea, which would consist of a statement identifying source of knowledge, understanding, ability or characteristic reaction of the examinee The difficulty of obtaining item ideas depend on the nature of the item desired If the purpose of the test is simply to determine whether or not the examinee possesses certain information, item ideas are obtained rather simply If on the other hand, a serious effort is being made to measure understanding ability to interpret and evaluate materials and similar characteristics of the examinee, the task of obtaining item ideas is much more difficult.

The following suggestions could be considered as general guidelines for developing proper test items:

1 Items should be expressed as clearly as possible.
2 Only such words should be chosen, which have precise meaning; and complex or awkward word arrangements should be avoided.

3. All qualifications needed to provide a reasonable basis for response selection should be included.
4 Non-functional words should not be included
5. Unessential specificity in the stem or the response should be avoided.
6 Irrelevant inaccuracies in any part of the item should be avoided
7. The level of difficulty of the items should be adapted to the group and purpose for which it is intended.
8 Irrelevant clues to the correct response should be avoided.
9 In order to defeat the rote learners, stereotyped phraseology in the stem or the correct response should be avoided
10 Irrelevant sources of difficulty should be avoided.
11 In multiple-choice items :
    (a) Either a direct question, or an incomplete statement on the item stem should be used
    (b) In general, words that must otherwise be repeated in each response should be included in the stem itself.
    (c) Negatively stated item stems should be avoided.
    (d) All responses should be made grammatically appropriate to the stem
    (e) Responses that overlap or include each other should be avoided.
    (f) 'None of these' as a response should be used only in items to which an absolutely correct answer can be given. This response should be avoided as the answer to items in which it may cover a large number of incorrect responses
    (g) If the item deals with the definition of a term, it is often preferable to include the term in the stem and present alternative definition in the response. (5)

Concluding Remarks

Assessment made by class teachers, internal examiners provide basic infomation which may lead to important decisions in the education process, affecting both the student and the teacher Information from the test evaluation procedure may also lead to modification of curriculum objectives, and serve to guide learning experiences better. Thus, it will be proper to hope that improvement in test-evaluation processes will lead to improvement in the total instructional package

The present publication, *Test Items in Chemistry* for Class XII has been produced keeping in view this hope of improving the total instructional package Based strictly on the NCERT chemistry textbook for Class XII brought out in May 1989, the publication is basically divided into three parts. The first, the main body of the publication, has test items on the 18 units of Parts I and II of the NCERT chemistry textbook, followed by the 'key' to all the items, and finally, the solutions of every numerical problem included in the test items No question present in the exercises at the end of the units in the textbook has been included in the test items.

The present publication is meant for teachers as well as students. It is hoped that the test items would not only help the teacher assess the students' progress, but also based on students' responses the test items could help the teachers improve the quality of their teaching and modify their ways of teaching if need be.

The students could find the test items useful in their effort to understand the subject and in their preparation for examinations; the test items could also help the students develop a 'self-concept' and assist them with 'self-assessment' Paper-setters and examiners may also find the publication useful.

REFERENCES

1. Bloom, B.S (ed) *Taxonomy of Education Objectives, The Classification of Educational Goals Handbook I· Cognitive Domain,* Longman Green Co , pp. 207, 1956.
2. Bloom, B S *Evaluation in Secondary Schools,* All India Council of Secondary Education, New Delhi, pp. 233, 1958
3. Dunn, S S *Measurement and Evaluation in Secondary Schools,* Australian Council for Education Research, pp. 131, 1987.
4. Wilhems, T T. *Evaluation on Feedback and Guide,* Association for Supervision and Curriculum Development, NEA, pp 282, 1967.
5. Lindquist, E P. *Educational Measurement,* American Council of Education, pp. 808, 1955.

UNIT I

Structure of Atoms and Molecules

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer .

1.1 According to Heisenberg's uncertainty principle the product of the uncertainties in the position (Δx) and momentum (Δp) is never smaller than :

(a) h
(b) h/2
(c) h/2π
[✓ (d) h/4π]
where h is Planck's constant.

1.2 Wavelength (λ) of an electron in motion is related to its velocity (v), and mass (m) by the expression :

(a) $\lambda = \frac{mv}{h}$
(b) $\lambda = \frac{v}{hm}$
(c) $\lambda = \frac{m}{hv}$
[✓ (d) $\lambda = \frac{h}{mv}$]
where h is Planck's constant.

1 3 The ionisation energy for the hydrogen atom has a value of .

(a) + 1 312 × 10^6 J mol^{-1}
[✓ (b) – 1.312 × 10^6 J mol^{-1}]
(c) + 1 312 × 10^6 J
(d) – 1 312 × 10^6 J

1.4 If the ionisation energy for the hydrogen atom in the ground state has a value of +13.12 × 10^5 J mol^{-1} then the energy of the electron corresponding to the first excited state is .

(a) – 3.28 × 10^5 J mol^{-1}
(b) – 6 56 × 10^5 J mol^{-1}

(c) -26.24×10^5 J mol^{-1}
(d) -52.48×10^5 J mol^{-1}

1.5 The energy of the ground state of the hydrogen atom is -2.17×10^{-18} J per atom. Its value in J mol^{-1} will be :
(a) -2.624×10^6 J mol^{-1}
(b) -4.34×10^{-18} J mol^{-1}
(c) -2.17×10^{-18} J mol^{-1}
(d) -1.312×10^6 J mol^{-1}

1.6 For the angular momentum quantum number $l = 4$, the magnetic quantum number m has a set of .
(a) 4 values
(b) 5 values
(c) 8 values
[✓ (d)] 9 values.

1.7 Which of the following atomic orbitals does not exist .
(a) 1s
(b) 2p
[✓ (c)] 2d
(d) 3d

1.8 The maximum number of electrons in the f orbital of an atom is :
(a) 6
(b) 10
(c) 12
[✓ (d)] 14

1.9 The hybridisation of sulphur in SF_6 is
(a) dsp^2
(b) sp^3d
[✓ (c)] sp^3d^2
(d) sp^3

1.10 The bond angle in SF_6 is :
(a) 180°
(b) 120°
(c) 109°
(d) 90°

1.11 Bond order (b.o.) is defined as .
(a) $2\,(N_b - N_a)$
(b) $\frac{1}{2}\,(N_a - N_b)$
[✓ (c)] $\frac{1}{2}\,(N_b - N_a)$
(d) $2\,(N_a - N_b)$
where N_b electrons occupy the bonding orbitals and N_a electrons are in the antibonding orbitals.

1.12 The value of the magnetic quantum number m for 's' electrons is :

(a) zero
(b) 1
(c) 2
(d) 3

1.13 The quantum number which describes the shape of an orbital is :

(a) n
(b) m
(c) l
(d) s

1.14 The ground state valence electron configuration for phosphorus (atomic No.15) is

(a) $3s^2$ $3p_x^1$ $3p_y^1$ $3p_z^1$
(b) $3s^1$ $3p_x^2$ $3p_y^1$ $3p_z^1$
(c) $3s^2$ $3p_x^1$ $3p_y^2$
(d) $3s^1$ $3p_x^1$ $3p_y^1$ $3p_z^1$ $3d^1$

1.15 An element has an atomic number 17. In the ground state, the value of the principal quantum number 'n' for the valence electrons is .

(a) 2
(b) 3
(c) 4
(d) 5

1.16 The following · H_2^+, He_2^+ and O_2 are all .

(a) diamagnetic
(b) paramagnetic
(c) unstable
(d) stable

1.17 For n = 3, the value of angular momentum quantum number cannot be :

(a) zero
(b) 1
(c) 2
(d) 3

1.18 Identify from the following the correct statement regarding bond order (b.o.) of a diatomic molecule :

(a) A positive b o means an unstable molecule.
(b) The stability of a diatomic molecule is proportional to its b.o.
(c) The dissociation energy of a molecule with b.o of two is less than that of a molecule with b o. one and a half
(d) The b.o. of the molecule increases with increase in bond length

(B) Completion Type

Complete the following .

1.19 For a sub-atomic object such as an electron, it is not possible to __________ determine the position and the velocity at any given instant to an arbitrary degree of precision.

1.20 For a given value of n, the _______ the value of l, the higher the energy

1.21 The relationship between wavelength (λ) of an electron of mass (m) in motion and its velocity (v) is given by the equation ________ .

1.22 For a 3d electron the value of the quantum number l is ___(i)___ and the possible values of the quantum number m are __(ii)__ .

1.23 The solution of the Schrodinger equation is called the _________ .

1.24 The Pauli exclusion principle states that no two electrons in an atom can have the same set of _______ quantum numbers.

1.25 The electrons in an atom are characterized by 4 quantum numbers n, l, m and s Their possible values are n: ____(i)__ , l : ___(ii)_, m . __(iii)__ and s . __(iv)__ .

1.26 The value of $(\psi)^2$ at any point is taken to represent the __________ of the charge cloud at that point.

1.27 A _________ bond order implies a stable molecule.

1.28 The bond order for He_2^+ is ________ .

1.29 Molecular orbitals obtained from p_y and p_x orbitals are not symmetrical around the bond axis and are labelled as _______ orbitals.

1.30 Molecular orbital of the sigma type (σ) is ________ about the internuclear axis.

1.31 The molecule BCl_3 is an example of a molecule with ______ hybridisation.

1.32 The sp^3d^2 hybrid orbitals are directed towards the corners of an ______ .

1.33 The adjacent angle between any two hybrid orbitals in a compound which exhibits dsp^2 hybridisation is _________

1.34 The atoms of neon and argon have a general electronic configuration of _________ .

1.35 When electrons are placed in different equal energy orbitals their spins should be ____(i)___ . It is called the ____(ii)__ .

1.36 In the homonuclear diatomic molecule A_2, the internuclear axis is defined as the z-axis. The $2p_x$ atomic orbitals centred on the two different atoms A will combine to form ___(i)___ molecular orbitals labelled as ___(ii)_, and ___(iii)___

1.37 Elements of the third period can undergo hybridisation involving the ____(i)____, ____(ii)____, and ____(iii)____ orbitals

1.38 In the molecular orbital energy level diagram of Ne_2 it is observed that the number of bonding molecular orbitals is ________ the number of antibonding molecular orbitals.

1.39 Molecules have characteristic molecular geometry because, lowering of energy is ________ for some definite arrangement of atoms for a molecule

(C) True and False Type

Classify the following statements as true (T) or false (F) ·

1.40 Dual nature, i e , particle and wave nature of matter is universal

1.41 The wavelength λ of the wave associated with a particular electron is directly proportional to the momentum of the electron.

1.42 A large negative value for the energy of an electron implies an unstable state.

1.43 To interpret an orbital, one needs to construct diagrams which show the variation of ψ in space

1.44 A quantum state of an electron (as described by a wave function) and its Bohr orbit are identical

1.45 An atomic orbital has a rigid boundary.

1.46 The values of the quantum number l and m are independent of the value of the principal quantum number n.

1.47 Orbitals which have a zero angular momentum quantum number are spherically symmetric

1.48 The p_z orbital has a nodalplane parallel to the z-axis

1.49 Two electrons in an atom will have identical values of n, l, m and s.

1.50 The process of bond formation between various atoms to form a molecule is accompanied by a release of energy

1.51 Bond order is always integral.

1.52 Electrons having a finite value of orbital angular momentum produce a magnetic field

1.53 Zero bond order for an Ne_2 molecule suggests that it cannot exist as a stable molecule

1.54 When a molecule is formed, the antibonding orbitals as a rule are unoccupied

1.55 The ammonium ion is an example of an sp^3 hybridisation.

1.56 H_2^+, He_2^+, O_2^+, O_2 and O_2^- are all examples of paramagnetic species.

1.57 A molecule exists if the number of electrons in the bonding levels are equal to those in the antibonding levels

1.58 The number of electrons in a neutral atom is equal to its atomic number.

1.59 Valence bond approach cannot explain the paramagnetic behaviour of the oxygen molecule.

(D) Matching Type

Match the items given in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B.

1.60

LIST A	LIST B
Item	*Unit*
(a) velocity of light	(i) J mol^{-1}
(b) ionisation energy	(ii) pm
(c) bond length	(iii) ms^{-1}
	(iv) Js

1.61

LIST A	LIST B
Molecule	*Electronic Configuration*
(a) oxygen	(i) $1s^2$
(b) beryllium	(ii) $1s^2\ 2s^2\ 2p^6\ 3s^2$
(c) magnesium	(iii) $1s^2\ 2s^2\ 2p^4$
(d) silicon	(iv) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
	(v) $1s^2\ 2s^2$

1.62

LIST A	LIST B
Name of Scientist	*Associated with Formula/Concept/Theory*
(a) Dalton	(i) $\Delta x \Delta p \geq \frac{h}{4\pi}$
(b) de Broglie	(ii) exclusion principle
(c) Heisenberg	(iii) dual nature of electron
(d) Mulliken	(iv) wave function (ψ)
(e) Pauli	(v) atomic hypothesis
(f) Pauling	(vi) VB theory
	(vii) MO theory

1.63

LIST A	LIST B
Molecule/Ion	*Hybridisation of the Central Atom*
(a) $BeCl_2$	(i) sp^2
(b) CO_3^{2-}	(ii) sp^3
(c) CH_4	(iii) sp^3d
(d) PCl_5	(iv) d^2sp^3
	(v) sp
	(vi) sp^3d^2

II SHORT-ANSWER TYPE

1.64 Considering the MO diagrams, in which of the following species O_2, C_2 and F_2, would you expect the bond length to increase (a) when an electron is added, (b) when an electron is removed

1.65 Phosphorus and sulphur form compounds like PF_5 and SF_6 but nitrogen and oxygen do not Explain

1.66 Which atomic orbitals are involved in the formation of PF_5? Which type of hybridisation occurs in this formation? What would be the value of the bond angle?

1.67 The bond energy determined for the N_2 molecule is greater than that for the O_2 molecule. Justify

1.68 Name the various orbitals corresponding to the principal quantum number n=3

1.69 State Heisenberg's uncertainty principle

1.70 What is meant by the dual nature of light? Why is it necessary to consider light to have a dual nature? Why do we not observe the wave nature of a cricket ball?

1.71 Write the molecular orbital configuration for the O_2 molecule On the basis of this (a) explain why O_2 is paramagnetic , (b) calculate the bond order.

1.72 Arrange the following species in order of increasing bond order—H_2 , H_2^+ , He_2

1.73 Since the uncertainty principle rules out the existence of definite trajectories, how is it that we continue to talk of paths of balls, cars, planets, etc

1.74 Although there are some similarities between a quantum state of an electron (as described by a wave function) and its Bohr orbit, there is an important difference. Comment.

1.75 How can one define the term 'molecules' from the point of view of chemical bonding? Why are molecules more stable than the constituent atoms?

III LONG-ANSWER TYPE ITEMS

1.76 With the help of a molecular orbital energy level diagram explain that (a) the bond order in N_2 molecule is three, (b) the molecule is diamagnetic Draw the shapes of the various molecular orbitals formed

1.77 Differentiate between the terms · (i) atomic orbit ; (ii) atomic orbital ; (iii) molecular orbital

1.78 The shape of the NH_3 molecule is different from that of the BF_3 molecule. Explain

1.79 The radius of a carbon atom as obtained from X-ray data is 77 pm. The C-C bond distances in ethane, ethene and ethyne are 154 pm, 133 pm and 120 pm, respectively Explain these observations.

1.80 What are the differences between the valence bond (VB) and molecular orbital (MO) approaches used in explaining bonding in molecules?

1.81 The electronic configuration of C is $1s^2\ 2s^2\ 2p_y^1\ 2p_z^1\ 2p_x^0$. Is the energy of $2p_x$ identical to that of $2p_y$ and $2p_z$ in this state? Justify your answer.

1.82 What is Hund's rule? Use this to explain the configuration of nitrogen atom and fluorine atom

IV. NUMERICAL PROBLEMS

1.83 What is the de Broglie wavelength of a mass of 10^{-3} kg travelling at a speed of 10^{-2} ms^{-1}? (Given Planck constant is 6.6×10^{-34} kg m^2s^{-1}.)

1.84 An electron is confined to a linear region of length 0.1 nm. What is the minimum uncertainty in its linear momentum? (Given Planck constant is 6.6×10^{-34} kg m^2s^{-1}.)

1.85 The speed of an electron moving at 600 ms^{-1} is measured to an accuracy of 0.004% What would be the minimum error in determining its position? (Given mass of an electron is 9.1×10^{-31} kg, and Planck constant is 6.6×10^{-34} kg m^2s^{-1}.)

1.86 The energy for the nth level of the hydrogen atom can be written as·

$$E_n = \frac{-1.312 \times 10^6}{n^2}\ J\ mol^{-1}$$

Given Planck constant is 6.6×10^{-34} Js and Avogardo constant is 6.023×10^{23} mol^{-1},

(a) What would be the energy required to excite an electron from n = 2 to n = 3?

(b) Once the electron has been excited to n = 3 level what would be the frequency of the light emitted when it returns to the ground state?

(c) What would be the wavelength corresponding to this radiation in (b)? (Given velocity of light is 3×10^8 ms^{-1})

1.87 What would be the wavelength of the electromagnetic radiation required to form Li^+ from Li atom? Given that ionisation energy of lithium is 0.52×10^6 J mol^{-1}, velocity of light is 3×10^8 ms^{-1}, and Planck constant is 6.6×10^{-34} Js.

1.88 Using the de Broglie relationship calculate :

(a) the wavelength of an electron

(b) the wavelength of a bug, and show that even for a small bug, the value of the wavelength is so small, that it can be safely neglected.

Given, Planck constant h = 6.6×10^{-34} kg m^2s^{-1}

mass of an electron	9.1×10^{-31} kg
mass of the bug	1.5×10^{-6} kg
velocity of the bug	2.0 ms^{-1}
velocity of electron	4.0×10^4 ms^{-1}

UNIT 2

The Solid State

I. OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer .

2.1 The % of free space in a body centred cubic crystal structure is :
- (a) 74
- (b) 68
- (c) 37
- (d) 25

2.2 The % of occupied space in a face centred cubic crystal structure is :
- (a) 74
- (b) 70
- (c) 68
- (d) 37

(Hint: For 2.1 and 2.2, please see solved numerical 2.90.)

2.3 Let the radius of a sphere in the closed packing be R and that of the octahedral void be r Then
- (a) r = 0.414 R
- (b) r = 0.73 R
- (c) r = 0.212 R
- (d) r = 0.51 R

2.4 In a rock salt-type crystal structure, the coordination number of each ion is :
- (a) 2
- (b) 4
- (c) 6
- (d) 8

2.5 In zinc sulphide the sulphide ions .
- (a) form the CCP structure
- (b) are found in the octahedral voids

(c) are found in all the tetrahedral voids
(d) are found in alternate tetrahedral voids.

2.6 The most efficient packing is found in .
(a) HCP only
(b) CCP only
(c) both HCP and CCP
(d) neither HCP nor CCP.

2 7 In the CsCl type structure, the number of units per unit cell is :
(a) 8
(b) 6
(c) 4
(d) 1

2 8 In CaF_2 structure, the number of F^- that surrounds each Ca^{2+} is ·
(a) 8
(b) 6
(c) 4
(d) 2

2 9 Identify the incorrect statement regarding the chlorides, bromides and iodides of lithium, sodium, potassium and rubidium :
(a) They possess the NaCl structure.
(b) The coordination involved in their structure is 6 6.
(c) They transform to the CsCl structure on application of high pressure.
(d) On applying high pressure, the coordination involved in their structure remains unchanged to 6:6

2 10 The crystal structure of caesium chloride is a ·
(a) body centred cubic structure
(b) face centred cubic structure
(c) tetrahedral structure
(d) simple cubic structure

2.11 In a compound of the type AB having a FCC structure, the number of AB units per unit cell will be :
(a) 1
(b) 2
(c) 3
(d) 4

2 12 In a compound of the type AB having body centred cubic structure, the number of AB units per unit cell will be .
(a) 1
(b) 2
(c) 3
(d) 4

2.13 Pyrosilicates contain the anion :
(a) $(Si_2O_7)^{6-}$
(b) $(SiO_4)^{4-}$
(c) $(Si_3O_9)^{6-}$
(d) $(Si_6O_{18})^{12-}$

2.14 Identify the incorrect statement regarding silicates :
(a) The basic building unit of all silicates is the SiO_4 tetrahedron.
(b) Sharing of corners of one SiO_4 tetrahedron with corners of other SiO_4 tetrahedron results in various kinds of silicates structures.
(c) Silicate structures are more close-packed than other oxide structures.
(d) Silicon in SiO_4 can be replaced by elements such as aluminium.

2.15 Lead zirconate is a typical .
(a) ferroelectric
(b) ferrielectric
(c) anti-ferrielectric
(d) anti-ferroelectric.

2.16 Some of the polar crystals when heated produce a small electric current, or :
(a) piezoelectricity
(b) pyroelectricity
(c) ferroelectricity
(d) ferrielectricity.

2.17 Frenkel defects .
(a) are found in pure alkali halides
(b) are not found in silver halides
(c) change the density of the solid
(d) can arise from a combination of the two basic types of point defects (Schottky and interstitial.)

2.18 When $CdCl_2$ is added to AgCl :
(a) the number of cation vacancies created in the crystal lattice is equal to the divalent cation Cd^{2+}
(b) the number of cation vacancies created in the crystal lattice is double the number of Cd^{2+} ions
(c) the number of cation vacancies created in the crystal lattice is half the number of Cd^{2+} ions
(d) no cation vacancies are created, instead anion vacancies are created whose number is equal to that of Cd^{2+} ions.

2.19 Ferrimagnetism is found when magnetic moments are aligned :
(a) in parallel and antiparallel directions in equal numbers
(b) all in one direction pointing upwards
(c) all in one direction but pointing downwards
(d) in parallel and antiparallel directions in unequal numbers.

2.20 Amorphous solids
- (a) have sharp melting points
- (b) possess long range order
- (c) have some local or short range order
- (d) left to themselves, even at ordinary conditions, always end up being crystalline.

(B) Completion Type

Complete the following:

2.21 In a cubic structure, each corner atom or ion contributes ____________ portion to an unit cell.

2.22 Number of units of Cs^+ per unit cell of CsCl is ________________

2.23 All silicates have the basic building unit of ____________ tetrahedron

2.24 Aluminosilicates can be obtained by replacing ___(i)___ in SiO_4 by ___(ii)___ .

2.25 Asbestos contains________ chains

2.26 Clays are silicates containing _______ type anions

2.27 When _________ corners of the SiO_4 tetrahedron are shared we get quartz

2.28 If the cell edge of a cubic unit cell is x cm, then the volume of the unit cell would be ____________

2.29 The presence of a large number of Schottky defects in a crystal __________ its density

2.30 _________ defects do not change the density of the solid.

2.31 Electrons trapped in anion vacancies are referred to as __________ centres

2.32 Excess of potassium in KCl makes the crystal appear _________ .

2.33 Solid solutions of group 13 elements with group 14 elements create electron deficient bonds or _______ .

2.34 Impurity doped silicon and germanium behave as ____________ whose conductivity increases with increasing temperature

2.35 Based on its response to an external magnetic field, TiO_2 can be classified as _____________

2.36 Due to randomisation of spins, ferrimagnetic Fe_3O_4 becomes ____________ at 850 K.

2.37 In paramagnetic material there are permanent magnetic ____________ .

2.38 In a magnetic field _______ substances are weakly repelled.

2.39 ___(i)___, ___(ii)___, and ___(iii)___ are three elements which show ferromagnetism at room temperature

2.40 Holes can move in crystals giving rise to ________.

2.41 If the alignment of magnetic moments is in a compensatory way so as to give zero net moment, then we get ________ in the material.

2.42 Based on their electrical conductivity, solids can be broadly classified as ___(i)___, ___(ii)___, and ___(iii)___

2.43 With increase in temperature the electrical conductivity of semiconductors ___(i)___ whereas that of metals ___(ii)___ .

(C) True or False Type

Classify the following statements as true (T) or false (F) :

2.44 The number of Cl^- per unit cell in NaCl type structure is calculated to be 2.

2.45 The coordination number of Cs^+ and Cl^- in CsCl type structure is 6

2.46 The coordination number of both Na^+ and Cl^- in NaCl type structure is 6.

2.47 Sodium chloride crystals have FCC unit cells.

2.48 The structure of NaCl is of fluorite type.

2.49 CaF_2 is an example of an antifluorite structure.

2.50 Na_2O has an antifluorite structure

2.51 In fluorite type structure, each F^- is coordinated by four Ca^{2+} ions and each Ca^{2+} ion is surrounded by eight F^- ions

2.52 If the impurity ions are in same valence state as the host ions, vacancies are created

2.53 When an atom is missing from its normal lattice site, a Frenkel defect results.

2.54 In the normal spinel structure, the divalent cations (Mg^{2+}, Fe^{2+}) are in octahedral voids and the trivalent ions (Fe^{3+}, Al^{3+}) are in tetrahedral voids.

2.55 Amorphous solids possess no order at all — neither long range nor short range

(D) Matching Type

Match the items given in List A with the items in List B, indicating the serial number of the item of List A, against that of List B

	LIST A *Property*		LIST B *Name*
2.56 (i)	conductivity increases with increasing temperature	(a)	Frenkel defect

(ii) conductivity decreases with increasing temperature	(b) Schottky defect
(iii) defect that changes the density of the solid	(c) semiconductors
(iv) imperfections extending along surfaces	(d) metals
	(e) plane defects
	(f) line defects

2.57

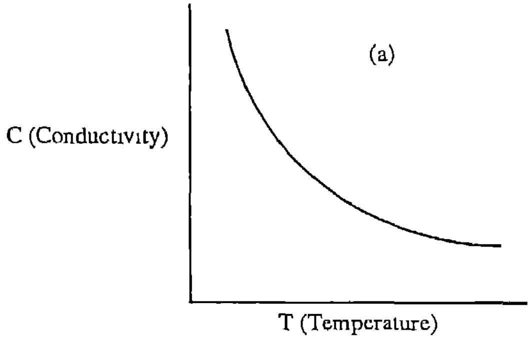
LIST A *Name*	LIST B *Property*
(i) NaCl type structure	(a) body centred cubic lattice
(ii) CsCl type structure	(b) normal spinel structure
(iii) wustite	(c) non-stoichiometric oxide
(iv) ferrite	(d) A triangular void surrounded by 4 spheres
	(e) face centred cubic lattice

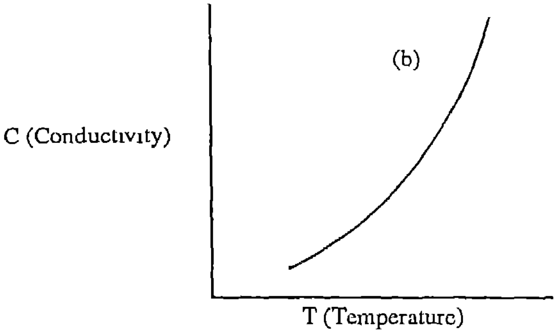
2.58

LIST A *Property*	LIST B *Compound*
(i) diamagnetic	(a) Fe_3O_4
(ii) anti-ferromagnetic	(b) CrO_2
(iii) ferrimagnetic	(c) MnO
(iv) ferromagnetic	(d) Ti_2O_3
	(e) TiO_2

II SHORT-ANSWER TYPE ITEMS

2.59 The following two graphs represent conductivity as function of temperature Predict, giving reasons the types of substances which will show these types of curves.





2.60 "Ionic sizes determine the nature of packing in the close packed structures" Explain this statement with the example of the ZnS and the NaCl crystals

2.61 When As is added to Ge crystal what change in conductivity do you expect?

2.62 What are F-centres?

2.63 What are piezoelectric crystals? How do they produce electric current?

2.64 Octahedral voids are larger than tetrahedral voids. Do you agree? Support your answer with valid reasons

2.65 How can you explain the enhanced electrical conductivity of non-stoichiometric ZnO?

2.66 Explain, along with a neat diagram, how chain structure of silicates can be obtained from the basic units SiO_4^{4-}

2.67 What do you understand by "doping". Why is it done?

2.68 What is meant by the term 'superconductivity'?

2.69 What is coordination number for a crystal?

2.70 What is the coordination number of a particle in HCP and CCP stacks? Explain

2.71 What are photovoltaics?

2.72 What are ferromagnetic substances? How can their behaviour in magnetic field be explained?

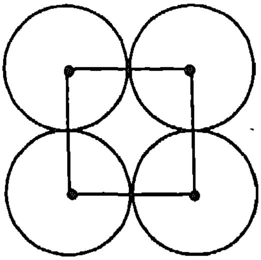
2.73 How is the electrical conductivity of semiconductors different from that of metals?

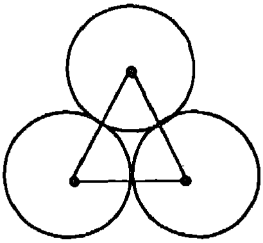
2.74 What are non-stoichiometric compounds? Give an example.

2.75 What is the basic difference between quartz and glass, formed by melting SiO_2 followed by cooling?

2.76 Establish the formula of sodium chloride from its crystal structure.

2.77 Two ways of packing spherical ions in one plane are shown in the figures given below:


A


B

Prove that B is the more efficient method of packing.

2.78 Solid solution of group 13 or group 15 impurities with group 14 elements are found to exhibit unusual electrical properties Why?

III. LONG-ANSWER TYPE ITEMS

2.79 Crystal structure of a compound of the type AB is generally cubic. What are the different forms that it may possess? Explain

2.80 How many types of imperfections are generally found in a crystal? Explain them briefly.

2.81 Distinguish between the following:

(i) HCP and CCP
(ii) Frenkel and Schottky defects
(iii) conductivity by metals and conductivity by semiconductors
(iv) ferroelectricity and antiferroelectricity
(v) piezoelectrics and pyroelectrics
(vi) ferromagnetism and ferrimagnetism.

2.82 Discuss the salient features in CCP structure.

2.83 In a crystal, account for its :
(i) electrical properties
(ii) magnetic properties
(iii) dielectric properties.

2.84 Describe the packing in an antifluorite structure crystal

2.85 Give some examples of how SiO_4 tetrahedra can be linked. Illustrate your answer with suitable diagrams

IV. NUMERICAL PROBLEMS

2.86 Calculate the number of atoms per unit cell in :

(i) a simple cubic arrangement

(ii) a body centred cubic arrangement

(iii) a face centred cubic arrangement.

2.87 Given that the edge of the unit cell in a face centred cubic arrangement is 36.08 nm Calculate the volume occupied by 6.02×10^{23} atoms in this unit cell

2.88 Metallic silver has a face centred cubic arrangement The unit cell edge is 407.8 pm. Calculate its density (Given atomic mass of silver is 107.87 g mol^{-1})

2.89 Gold crystallises in face centered cubic arrangement. Given that the observed unit cell length is 40.70 nm, calculate the radius of a gold atom.

2.90 Calculate the packing efficiency of a face centred cubic crystal

2.91 Lithuim crystalises in a BCC structure If the edge length of the unit cell is 353 pm, calculate: (i) the radius of a Li atom, (ii) the packing efficiency of the unit cell

2.92 For a face centred unit cell of an element, the edge length is 352.39 pm. If the density of the element is 8.9 g cm^{-3}, find the Avagadro constant (Given, atomic mass of the element is 58.7 g mol^{-1})

2.93 A substance forms face centred cubic crystals If the edge length of the unit cell is 630 pm and the density of the substance is 1.984 g cm^{-3}, calculate the molar mass of the substance.

2.94 A unit cell consists of a cube in which there are anions (B) at each corner and one at the centre of the unit cell and cations (A) at the centre of each face. What is the simplest formula of the unit cell?

UNIT 3

Solutions

I. OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer :

3.1 Molarity is expressed as the number of moles of a solute per .
- (a) dm^3 of solution
- (b) dm^3 of solvent
- (c) 1 kg of solvent
- (d) kg of solution.

3.2 Molality (m_B) is expressed as
- (a) $m_B = \frac{1000 n_B}{w_A}$
- (b) $m_B = \frac{1000 w_A}{w_B}$
- (c) $m_B = \frac{1000 w_B M_B}{w_A}$
- (d) $m_B = \frac{1000 w_B M_B}{w_A}$

where n_B is the number of moles of solute, w_A and w_B are number of grams of the solvent and the solute, respectively, and M the molecular weight of the solute.

3.3 When HgI_2, is added to a solution of KI :
- (a) freezing point of the solution is raised
- (b) freezing point of the solution is lowered
- (c) boiling point does not change
- (d) boiling point is lowered

3.4 Which of the following statements regarding solutions is *not* true
- (a) Solutions are homogeneous mixtures.
- (b) A mixture of two or more substances whether homogeneous or heterogeneous is known as a solution
- (c) Solutions can be formed when even one of the components is not a liquid
- (d) Ordinary water is a solution

3.5 When a solution of two miscible liquids is heated,
- (a) ratio of the more volatile to the less volatile component decreases
- (b) ratio of the more volatile to the less volatile component increases
- (c) there is no change in the ratio of the more volatile to the less volatile component
- (d) nothing can be predicted about the ratio of the more volatile to the less volatile component.

3.6 The unit of Molality is :
- (a) mol dm^{-3}
- (b) mol L^{-1}
- (c) mol kg^{-1}
- (d) mol x $10^3 m^{-3}$

3 7 The mole fraction of ethanol in a solution containing 46 g of ethanol and 90 g of water is
- (a) .017
- (b) 167
- (c) .833
- (d) 083

3.8 You are given a solution of $C_6H_{12}O_6$ and a solution of NaCl, in which equal weights of $C_6H_{12}O_6$ and NaCl are dissolved in equal volume of water.
- (a) The two solutions will have same depression of freezing point
- (b) The two solutions will have same elevation of boiling point.
- (c) The NaCl solution will have larger depression of freezing point than the $C_6H_{12}O_6$ solution.
- (d) The $C_6H_{12}O_6$ solution will have a larger depression of freezing point than the NaCl solution.

3.9 Colligative properties of solutions are those properties which depend on ·
- (a) the number of solute molecules (or ions) only.
- (b) the number of solvent molecules (or ions) only
- (c) the number of both solute and solvent molecules (or ions)
- (d) the nature of both solute and solvent molecules (or ions)

3.10 If p_A is the partial vapour pressure of the solvent in a solution and p_A° that of the pure solvent, then Raoult's law can be written as :
- (a) $p_A = p^\circ_A x_A$

(b) $p_A = p_A^o x_B$

(c) $p_A = p_A^o \frac{x_A}{x_B}$

(d) $p_A = p_A^o \frac{1}{x_A}$

where x_A and x_B are the mole fractions of the solvent and the solute, respectively.

3.11 At the freezing point of a solvent :
(a) the solid and the liquid are at equilibrium
(b) the solid and the liquid are not at equilibrium
(c) the solid and the liquid have unequal vapour pressure
(d) the solid that separates out is never pure

3 12 For a solution of NaCl in water, van't Hoff factor is·
(a) > 1
(b) < 1
(c) $= 1$
(d) $= 0$

3 13 Benzoic acid when added to benzene dimerizes The value of van't Hoff factor will be :
(a) >1
(b) <1
(c) $=1$
(d) $=0$

3.14 The passage of solvent through a semipermeable membrane can be stopped if adequate pressure is applied on the solution side This pressure is known as :
(a) vapour pressure
(b) atmospheric pressure
(c) osmotic pressure
(d) relative vapour pressure

3 15 In a mixture of two volatile liquids ·
(a) the vapour will have greater proportion of the more volatile liquid
(b) the vapour will have greater proportion of the less volatile liquid
(c) the vapour will have same amount of both the liquids
(d) the proportion of the amount of volatile liquid in the vapours will be independent of the volatility of the liquids

3.16 Molal boiling point elevation constant is expressed in the unit ·
(a) K kg mol^{-1}
(b) kg mol^{-1} K^{-1}
(c) kg. mol K^{-1}
(d) K kg^{-1} mol^{-1}

3.17 Observed colligative property is :
- (a) i X (calculated colligative property)^2
- (b) calculated colligative property ÷ i
- (c) i – calculated colligative property
- (d) i X (calculated colligative propety)$^{-2}$

where i is the van't Hoff factor to express the extent of association or dissociation of a solute.

3.18 When gram seeds are soaked in water overnight, their size increases because water enters the seeds due to :
- (a) osmosis
- (b) diffusion
- (c) adsorption
- (d) absorption

3.19 The concentration of a gas A is 10 ppm. This means that 10 cm^3 of the gas A is present in
- (a) 1 L of air
- (b) 10 L of air
- (c) 100 L of air
- (d) 1000 L of air

3.20 Ethylene glycol is added to water in the radiator of a car engine to :
- (a) purify the water
- (b) increase the density of water
- (c) lower the freezing point of water
- (d) elevate the boiling point of water.

(B) Completion Type

Complete the following :

3.21 Mole fraction is the ratio of the ________.

3.22 ____________ is defined as the number of moles of solute dissolved per kg of the solvent.

3.23 Molarity is defined as the number of moles of solute per dm^3 of _________ .

3.24 Homogeneous mixture of two or more components is called a __________

3.25 Organic compounds dissolve more in _____(i)_____ solvents and ionic solids dissolve more in_____(ii)_____solvents

3.26 Pressure exterted by the vapour of a liquid in equilibrium with it at a given temperature is called the _________ of the liquid at that temperature.

3.27 Ratio of : decrease in vapour pressure on formation of a solution, to the vapour pressure of the pure solvent is called the _________ .

3.28 On dissolving a solute, the vapour pressure of the solvent is ________ .

3.29 In a solution of volatile liquids the partial vapour pressure of each component in the solution is directly proportional to its ________ .

3.30 In a solution which is obtained by adding a non-volatile solute to a volatile solvent the total vapour pressure will be equal to the vapour pressure of the ________ .

3.31 In Raoult's law relation $p_s = x_s p_s^o$, the quantity p_s^o denotes the ________ .

3.32 The total vapour pressure of a solution for any composition is given by the sum of ___(i)___ , as required by ___(ii)___ law.

3.33 The temperature at which the vapour pressure of a solution equals the atmospheric pressure will be ________ than the temperature at which the vapour pressure of the pure solvent equals the atmospheric pressure.

3.34 In a solution of two volatile liquids, the composition of the liquid and the vapour phase is ________ .

3.35 In a solution of two volatile liquids total vapour pressure will have higher contribution of the ________ liquid.

3.36 Colligative properties of solutions are those properties which depend on the ________ present in the solution.

3.37 The molecular mass of sodium chloride in water when determined experimentally is found to be ________ than that of the expected value.

3.38 For a solution of two components A and B, a positive deviation from ideal behaviour is exhibited by liquid pairs for which the A-B molecular interaction forces are ________ than the A-A or the B-B molecular interaction forces.

3.39 When chloroform and acetone are mixed, hydrogen bonding occurs between the two molecular species This___(i)___the escaping tendency of molecules of each component and as a result the vapour pressure___(ii)___ .

3.40 Liquids boil when their vapour pressure equals the ________

3.41 The boiling point of a solvent is ________ by the presence of a solute in it.

3.42 Elevation of boiling point for one molal solution is same as its ________ .

3.43 When a non-volatile solute is added to a liquid the boiling point is ___(i)___ and freezing point___(ii)___.

3.44 According to ________ law, a plot of p_A or p_B against x_A or x_B for a solution should give a straight line.(p_A and p_B represent the partial vapour pressure of two miscible liquids A and B, and x_A and x_B are their respective mole fractions.)

3.45 For a solution obtained by adding a non-volatile solute to a volatile solvent, as the mole fraction of the solvent in the solution decreases, the vapour pressure ________ .

3.46 Osmotic pressure is the pressure applied on the ____(i)____ side to prevent the passage of the ____(ii)____ through a semipermeable membrane.

3.47 The unit of molal freezing point depression constant is ________.

3.48 A membrane which allows only ________ molecules to pass through is called a ________ membrane.

3.49 There are — types of non-ideal solutions.

3.50 The observed value of a colligative property is greater than the expected value when the solute molecules ________ in the solution

3.51 In terms of molecular mass van't Hoff factor is defined as : i = ________ .

3.52 In case of association the value of van't Hoff factor (i) will be ________ than unity, while for dissociation it will be ________ than unity.

3.53 Observed molar mass of benzoic acid in benzene is much higher than its normal molar mass, whereas in water it is much less than its normal molar mass. This is because in benzene, benzoic acid is ________, and in water it is ________ .

3.54 Dissolved gases are removed from water by ________ .

(C) True and False Type

3.55 Classify the following statements as true (T) or false (F) :

(i) Molarity is defined as the number of moles of solute per dm^3 of solvent

(ii) Molarity is defined as the number of moles of solute per dm^3 of solution.

(iii) Molality is defined as the number of moles of solute per dm^3 of solution

(iv) Mole fraction is expressed in mol/dm^3.

(v) Unit of molarity is mol dm^3.

3.56 (i) To represent concentrations of very small order, the unit that is generally used is ppm

(ii) Molality of a solution does not change with temperature of solution.

(iii) If a non-volatile solute is added to a solvent to make a solution, the vapour pressure of the solution will be less than that of the pure solvent.

(iv) Colligative properties are those which depend on the nature of the solute and solvent particles.

(v) Vapour pressure of an ideal solution always lies intermediate between the vapour pressure of its pure components.

3.57 (i) Total vapour pressure of an ideal solution of volatile liquids is equal to the sum of the partial vapour pressures of the pure liquids.

(ii) The relative lowering of vapour pressure for a solution is equal to the mole fraction of the solute when solvent alone is volatile.

(iii) When the temperature of a liquid is raised, its vapour pressure decreases.

(iv) A solution is termed an ideal solution if:
  (a) it obeys Raoult's law and
  (b) ΔH_{mix} is +ve, and
  (c) ΔV_{mix} is -ve

(v) The boiling point of a liquid changes with the change in atmospheric pressure.

3.58 (i) Molality remaining the same, and using the same solute, the elevation of boiling point changes when the nature of the solvent is changed

(ii) The boiling point of a liquid is raised on adding a soluble substance because the latter lowers the vapour pressure of the solvent

(iii) The excess pressure applied on a solution to prevent osmosis is called osmotic pressure.

(iv) Osmosis is a process in which both the solvent and the solute molecules pass through a semipermeable membrane

(v) A solution is said to exhibit a negative deviation from ideal behaviour when the total vapour pressure of the solution is less than that required by Raoult's law.

3 59 (i) van't Hoff factor is defined as the observed colligative property ÷ normal colligative property.

(ii) Non-ideal solutions can show positive as well as negative deviations from ideal behaviour.

(iii) Equimolar aqueous solution of sugar or salt has the same osmotic pressure.

(iv) Molarity of a solution changes with temperature but molality remains constant

(v) Solutes which undergo dissociation or association in solution have no effect on the collegative property of the solution.

3.60 (i) Molal boiling point elevation constant of a solvent is same as the elevation of boiling point that occurs in a one molar solution.

(ii) If the same mass of sugar is dissolved in pure water, the molarity and the molality of the solution will be the same.

(iii) In a solution of benzoic acid in benzene, the value of van't Hoff factor is 0 5. Therefore, the observed molar mass of benzoic acid in benzene will be half its actual molar mass.

(iv) A molar aqueous solution of NaCl will have a higher boiling point than a molar aqueous solution of barium chloride.

(v) Ordinary water is an example of a solution.

(D) Matching Type

Match the items given in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B.

3.61

LIST A *Quantity/Concept*	LIST B *Definition/Stands for*
(i) Molarity	(a) number of moles of solute dissolved in 1L of solution
(ii) The relative lowering of vapour pressure of a solution is equal to the mole fraction of the solute when solvent alone is volatile.	(b) Raoult's law
(iii) van't Hoff factor (i)	(c) $\frac{\text{mole of solvent}}{\text{total number of moles}}$
(iv) $i > 1$	(d) association of solute in solvent
(v) $i < 1$	(e) dissociation of solute in solvent
	(f) ratio of normal molar mass to observed molar mass
	(g) number of moles of solute per 1000 g of solvent.

II SHORT-ANSWER TYPE ITEMS

3.62 What is the name given to the properties of solutions which depend only on the number of particles and not on their nature? Name three such properties.

3.63 For a solution of volatile liquids, state the law that gives the relationship between the partial vapour pressure of each component in the solution and its mole fraction.

3.64 Which is the substance that is usually added to water in the car radiator to act as an anti-freeze?

3.65 By what process does water from the soil rise to the top of a tree?

3.66 What is that solution called whose experimental vapour pressure is higher than that of an ideal solution of the same composition?

3.67 What is the name of the concentration term used when quantity of the solute is expressed in mol and quantity of the solvent is 1 kg?

3.68 To express the concentration of extremely small order, which is the term that is generally used? Explain this term.

3.69 What is the term used for the ratio between the lowering of vapour pressure on formation of the solution and the vapour pressure of the pure solvent?

3.70 What term gives the ratio of normal molar mass to observed molar mass?

3.71 In a solution of two volatile liquids, partial pressure of each component is proportional to its mole fraction. What is the constant of proportionality in the two cases?

3.72 Why is the method using measurement of osmotic pressure adopted for obtaining molar mass of biological molecules?

3.73 If NaCl is fully dissociated when dissolved in water, what will be its experimental molar mass in solution when compared to its calculated molecular mass?

3.74 What are solid solutions? Give an example.

3.75 50 g each of water and ethanol are mixed together. Calculate their molar ratio.

3.76 State the relation between osmotic pressure and the number of moles of solute.

3.77 Why do a pair of miscible liquids show negative deviation from ideal behaviour?

3.78 If for two components A and B, A-B interactions are much weaker than the A-A or B-B molecular forces, what type of deviations will be exhibited by the solution?

3.79 What happens to the freezing point of water when a soluble salt is added?

3.80 Why does a molar solution of barium chloride have higher elevation of boiling point than a molar solution of sodium chloride?

3.81 What is meant by the term 'non-ideal solution'?

III LONG-ANSWER TYPE ITEMS

3.82 State and explain Raoult's law.

3.83 What are colligative properties? Discuss.

3.84 Discuss the phenomenon of depression of freezing point. How can it be used to calculate the molar mass of a non-volatile solute?

3.85 Differentiate between ideal and non-ideal solutions. Further, discuss the reasons for non-ideal behaviour of liquids

3.86 What is osmosis? Define osmotic pressure, and explain how it is used to determine the molar mass.

3.87 Arrange the following aqueous solutions, each of strength 0.1 M, in order of increasing freezing and boiling points. Justify your arrangement:

C_2H_5OH, $Ba_3(PO_4)_2$, Na_2SO_4, KCl, Li_3PO_4.

3.88 Discuss the abnormal colligative properties of electrolytes How did van't Hoff explain this abnormal behaviour?

3.89 Explain why lowering of vapour pressure is not a colligative property but relative lowering of vapour pressure is.

3.90 What is an ideal solution? What are the conditions that must be satisfied for forming such a solution?

3.91 What are non-ideal solutions? What does an ideal solution mean at the molecular level? Explain.

IV NUMERICAL PROBLEMS

3 92 An aqueous sugar syrup of mass 214 2 g contains 34.2 g of sugar (molar mass of sugar is 342 g mol^{-1}). Calculate (i) the molality of the solution, (ii) the mole fraction of sugar.

3.93 What volume of 10 N HCl should be diluted to 500 cm^3 such that 50 0 cm^3 of this solution is exactly neutralised by 25 0 cm^3 of a solution of Na_2CO_3 containing 10 6 g of it in 100.0 cm^3 of the solution? (Given atomic mass of Na is 23.)

3.94 An aqueous solution of ethanoic acid (molar mass 60 g mol^{-1}) containing 80.8 g dm^{-3} of ethanoic acid has a density of 1.0097 kg dm^{-3}. The total vapour pressure of the solution is 125 mm of Hg (at 323 K) The vapour pressure of ethanoic acid at the same temperature is 100 mm of Hg. Calculate the.

(i) mass per cent of water and of ethanoic acid
(ii) mole fraction of water and of ethanoic acid
(iii) molality of ethanoic acid
(iv) partial vapour pressure of ethanoic acid
(v) partial vapour pressure of water
(vi) vapour pressure of pure water.

3 95 Two liquids A and B form ideal solutions over a wide range of composition at 298 K. The vapour pressure of a solution at this temperature containing A and B in the mole ratio 1·2 is 300 mm of Hg. Another solution of A and B at the same temperature is in molar ratio of 1·1, and has a vapour pressure of 350 mm of Hg. Calculate the vapour pressure of pure A and B.

3.96 The non-volatile compound $C_6H_8O_2N_2S$ dissolves readily in C_3H_6O. What is the vapour pressure at 312.5 K of a solution containing 1.00 g of $C_6H_8O_2N_2S$ dissolved in 10.0 g of C_3H_6O, if the vapour pressure of pure C_3H_6O at this temperature is 4.00×10^2 mm of Hg?

3.97 A solution of 5.0 g of a polymer in 1 dm^3 of a solvent has an osmotic pressure of .096 kPa at 288.0 K Calculate the molecular mass of the polymer.

3.98 5 g of compound A was dissolved in 1.00×10^2 g of water at 303 K. The vapour pressure of the solution was found to be 4.16 kPa. If the vapour pressure of pure water is 4.24 kPa at this temperature, what is the molecular mass of A?

3.99 Let 7 39 g of A be added to 85.0 g of B. The resulting solution boils at 355. 6 K at standard pressure Calculate the approximate molecular mass of A (Given normal boiling point of B is 353.2 K and K_b is 2 53 K kg mol^{-1}.)

3.100 0.300 g of urea (molecular mass 60.1 g mol^{-1}) is dissolved in 10.0 g of water. Assuming ideal solution behaviour, calculate the boiling point of this solution. (Given K_b for water is 0.52 K kg mol^{-1})

3.101 The freezing point of a solution composed of 10.0 g of KCl in 100 g water is 268.5 K. Calculate the van't Hoff factor (i) for this solution given K_f water=1.86 K kg mol^{-1} and molecular mass, of KCl is 74.5 g mol^{-1}.

3.102 Calculate the normal boiling point of a sample of sea water containing 3.5% of NaCl and 0.13% of $MgCl_2$ by mass. Given K_b (water) = 0.51 K kg mol^{-1}, molecular mass of NaCl = 58.5 g mol^{-1} and molecular mass of $MgCl_2$ = 95 g mol^{-1}

3.103 A certain solution of benzoic acid in benzene has a freezing point of 276.1K and a boiling point of 355.6 K. Explain these observations based on the structure of solute particles at the two temperatures. Given, K_f (benzene) = 5.102 K kg mol^{-1}, K_b (benzene) = 2.53 K kg mol^{-1}, T_f (benzene), 278.5 K and T_b (benzene) 353.1K

UNIT 4

Chemical Thermodynamics

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answers :

4.1 Which of the following is a closed system?
- (a) a tree in a garden
- (b) coffee in a thermos flask
- (c) water in a beaker
- (d) a sealed tube containing solid iodine and iodine vapour

4.2 Which of the following is an extensive variable?
- (a) volume
- (b) surface tension
- (c) viscosity
- (d) density

4.3 Which of the following is not a state function?
- (a) $E + pV$
- (b) $q + w$
- (c) $\frac{q_{rev}}{T}$
- (d) q

4.4 Which of the following is not a spontaneous process?
- (a) spreading of an ink droplet in a beaker filled with water
- (b) yielding hydrochloric acid and sodium hydroxide from a solution of sodium chloride in water
- (c) evaporation of water at 373K and 101.325 kPa pressure
- (d) expansion of gas in vacuum

4.5 Identify the incorrect statement concerning Hess's law :
(a) Hess's law can be regarded as a consequence of the fact that enthalpy is a state function.
(b) When a reaction can occur in several stages, the overall enthalpy change must equal the sum of enthalpy changes for the individual steps. This statement is called Hess's law.
(c) Hess's law can be regarded as an expression for the entropy change of the system.
(d) Hess's law is most useful in practice when it is applied to a thermodynamic cycle.

4 6 One is studying the reaction of two substances A and B. The system will constitute the .
(a) beaker in which the mixture is kept
(b) room where the beaker is kept
(c) reaction mixture of A and B
(d) reaction mixture, the beakers, the room.

4 7 The heat of combustion of hydrogen gas at constant pressures and at 300 K is –280 kJ mol^{-1}. The heat of combustion at constant volume and at 300 K is ·
(a) – 280 kJ mol^{-1}
(b) – 283 74 kJ mol^{-1}
(c) – 276.26 kJ mol^{-1}
(d) – 277.51 kJ mol^{-1}

4.8 The standard absolute entropy of a substance, S^0, is the entropy of the substance in its standard state at 1 atm, temperature being :
(a) 0 K
(b) 298 K
(c) 398 K
(d) 273 K

4.9 Which of of the following equations correctly defines the enthalpy of formation of carbon monoxide?
(a) $2C(\text{graphite}) + O_2(g) \rightarrow 2CO(g)$
(b) $\frac{1}{2}C(\text{graphite}) + \frac{1}{2}CO_2(g) \rightarrow CO(g)$
(c) $C(\text{graphite}) + O(g) \rightarrow CO(g)$
(d) $C(\text{graphite}) + \frac{1}{2}O_2(g) \rightarrow CO(g)$.

4.10 For a spontaneous process, which of the following is always true?
(a) ΔG is > 0
(b) ΔS_{total} is < 0
(c) $-T \Delta S > 0$
(d) $\Delta G < 0$

4.11 If the enthalpies of combustion of diamond and graphite are respectively −395.4 kJ mol^{-1} and −393.6 kJ mol^{-1}, what is the enthalpy change for the reaction represented by the equation :

$$C(\text{graphite}) \longrightarrow C(\text{diamond})$$

(a) −789.0 kJ mol^{-1}
(b) −1.8 kJ mol^{-1}
(c) + 1.8 kJ mol^{-1}
(d) + 789.0 kJ mol^{-1}

4.12 The bond energy of hydrogen is 432.5 kJ mol^{-1}. It means that 432.5 kJ of heat :
(a) is required to break the bonds in one molecule of hydrogen(g) into ions (g)
(b) is required to break one mole of hydrogen molecules(g) into atoms (g)
(c) is evolved when one molecule of hydrogen (g) is broken into atoms(g)
(d) is required to break one mole of hydrogen (g) into ions(g)

4.13 Given ;

(i) $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g);\quad \Delta H = -\ 242\ \text{kJ mol}^{-1}$

(ii) the enthalpies of dissociation of $H_2(g)$ and $O_2(g)$ as + 436 kJ mol^{-1} and + 500 kJ mol^{-1}, respectively

The bond energy of the O–H bond in water is thus :
(a) + 121 kJ
(b) +222 kJ
(c) + 444 kJ
(d) + 464 kJ

4.14 Which one of the following has the same value as the standard enthalpy change of formation of carbon monoxide (CO)?

where ΔH^0_f = Standard heat of formation
ΔH^0_c = Standard heat of combustion

(a) $\frac{1}{2}\Delta H^0_f\,(CO_2)$

(b) $\frac{1}{2}\Delta H^0_c$ (graphite)

(c) $\Delta H^0_f\,(CO_2) - \Delta H^0_c$ (graphite)

(d) ΔH^0_c (graphite)$-\Delta H^0_c(CO)$

4.15 For which of the following processes is ΔS negative?
(a) $H_2(g) \rightarrow 2H(g)$
(b) $N_2(g,\ 1\ atm) \rightarrow N_2(g,\ 5\ atm)$
(c) $2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$
(d) C (diamond) → C (graphite)

4.16 Which of the following conditions predicts the feasibility of a reaction at all temperatures?
(a) ΔH+ve ; ΔS–ve
(b) ΔH+ve ; ΔS+ve
(c) ΔH-ve ; ΔS+ve
(d) ΔH-ve ; ΔS+ve

4.17 For the reaction A(g) → B(g) at 300K, the equilibrium is reached when the pressure of the product is one-tenth that of the reactants The value of G^0 for this reaction is .
(a) – 8.314 x 300 x 2.3 log 0.1 J mol^{-1}
(b) – 8.314 x 300 x 2.3 log 0.0 J mol^{-1}
(c) – 8.314 x 300 x 2.3 log 0.001 J mol^{-1}
(d) – 8.314 x 300 x 2.3 log 10 J mol^{-1}.

4.18 Which one of the following statements does not correctly represent the first law of thermodynamics?
(a) Energy can neither be created nor destroyed.
(b) Internal energy of a system does not depend on the state of the system
(c) Total energy of the universe is constant.
(d) The first law of thermodynamics is the same as the law of conservation of energy.

4.19 Entropy of a perfectly crystalline substance :
(a) decreases as temperature increases.
(b) can never be zero
(c) is zero at 0K.
(d) increases as temperature decreases.

4.20 When a reaction occurs in several steps, the overall enthalpy change equals the sum of the enthalpy changes for the individual steps. This was established by :
(a) Nernst
(b) Kelvin
(c) Joule
(d) Hess

(B) Completion Type

Complete the following :

4.21 When heat is absorbed by the system, the sign of the value of q is taken to be ________

4.22 A bomb calorimeter is used to measure the value of ___(i)___ at constant ___(ii)___.

4.23 The entropy of gases is always ________ than that of corresponding liquids

4.24 A system is ________, if it cannot exchange matter and energy with the surroundings

4.25 The value of an intensive variable is independent of the ________ of the system

4.26 The difference in the values of enthalpy change and change in the internal energy of the system becomes significant when ______ are involved

4.27 For polyatomic molecules, bond energy is taken to be the ______ dissociation energy of a bond of a given type

4.28 The standard free energy change is defined as the free energy change for a process at a temperature of ________, where the reactants and the products are at their standard states.

4.29 $\Delta G^0 = -2.303\ RT \log 4$. Therefore, value of equilibrium constant for the reaction is ______.

4.30 For the reaction $H_2(g) + Br_2(l) \rightarrow 2HBr(g)$, the value of $\Delta H = -72.40$ kJ mol^{-1}, the value of $\Delta G = -106.49$ kJ mol^{-1}. If the temperature is 300K and pressure 1 atm, then the value of ΔS is _____.

(C) True and False Type

Classify the following statements as true (T) or false (F) :

4.31 Although 'q' and 'w' are not state functions but their sum represents a state function.

4.32 The enthalpy of an element in its standard state is taken to be zero but not the entropy

4.33 The heating of milk in a milk boiler is a spontaneous process

4.34 The standard Gibbs free energy change is related to the equilibrium constant K of the reaction by the relation $\Delta G^0 = -RT \ln K$.

4.35 Entropy of all solids is zero at 0K.

4.36 If a cup of tea could become hot on its own in a spontaneous manner, the first law of thermodynamics would still be obeyed.

4.37 The lower the value of free energy change of a process, the greater is the amount of work that can be obtained from the process.

4.38 For a spontaneous process,

$$\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings} < 0.$$

(D) Matching Type

4.39 Match the items given in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B

LIST A *Quantity/Concept*	LIST B *Represented by*
(a) entropy	(i) $\Delta E = q + w$
(b) First law of thermodynamics	(ii) $E + P\Delta V + V\Delta P$

(c) ΔS_{fus}	(iii) $\frac{q_{rev}}{T}$
(d) ΔH	(iv) $-nFE^{\circ}_{cell}$
(e) ΔG^{0}	(v) $\Delta S - \frac{\Delta H}{T}$
	(vi) $\Delta H^{0} - (\Delta n)\ RT$
	(vii) $\frac{\Delta H_{fus}}{T}$

II. SHORT-ANSWER TYPE ITEMS

4.40 Define extensive and intensive variables. Classify the following into extensive and intensive properties :

(i) internal energy
(ii) enthalpy
(iii) heat capacity
(iv) vapour pressure
(v) entropy
(vi) dipole moment
(vii) standard electrode potential
(viii) surface tension
(ix) viscosity
(x) melting point

4.41 What are state functions? Which of the following are state functions?

(i) q
(ii) w
(iii) $q + w$
(iv) q_v
(v) q_p
(vi) $\frac{q}{T}$
(vii) $E + pv$

4.42 Which of the following processes are thermodynamically reversible and which are irreversible?

(i) mixing of two gases at constant temperature and pressure
(ii) dissolution of copper sulphate in water
(iii) expansion of a gas into vacuum
(iv) neutralization of an acid by a base
(v) expansion of a gas against constant external pressure
(vi) vaporisation of a liquid at its boiling point

4.43 For each of the following exothermic changes, explain whether the heat evolved at constant pressure is smaller than, larger than or equal to the heat evolved at constant volume :

(i) $C\ (\text{graphite}) + O_2(g) \rightarrow CO_2(g)$

(ii) $\frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g) \rightarrow HCl(g)$

(iii) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

(iv) $SO_2(g) + \frac{1}{2} O_2(g) \rightarrow SO_3(g)$

4.44 For each pair given below, identify the component which has the higher value of entropy :

(i) amorphous glass and crystalline glass
(ii) rhombic sulphur and monoclinic sulphur
(iii) a mechanical spring when it is coiled and the same spring when it is relaxed
(iv) a full boiled egg and a half-boiled egg
(v) a gas in the compressed state and the same gas in the expanded state (both at the same temperature)
(vi) a mole of ice at 273 K and a mole of water at the same temperature
(vii) solid NH_4Cl and a solution of NH_4Cl in water.

4.45 In the following processes, state whether the entropy of the system increases, decreases or remains unchanged

(i) solidification of a mole of liquid at its freezing point
(ii) crystallisation of a solute from its saturated solution
(iii) dissolution of a mole of common salt in water
(iv) mixing of two gases
(v) mixing of two partially miscible liquids

4.46 Explain why :

(i) coffee in a stoppered thermosflask is an isolated system
(ii) coffee in a covered stainless steel container is a closed system
(iii) coffee in an uncovered thermosflask or in an uncovered stainless steel container is an open system

4.47 What is meant by the internal energy of a system?

4.48 How can one change the internal energy of a system?

4.49 What is meant by the enthalpy of a system?
Prove $\Delta H = q_p$.

4.50 What is Hess's law?

4.51 How does one define the standard free energy change?

4.52 What is the third law of thermodynamics?

III LONG-ANSWER TYPE ITEMS

Define and explain the following terms :

(i) internal energy
(ii) enthalpy
(iii) state functions
(iv) system
(v) entropy
(vi) heat of combustion
(vii) heat of formation
(viii) bond energy

4.54 State the first law of thermodynamics. Give a mathematical statement for the law and explain each term involved in the statement.

4.55 Derive a relationship between ΔH and ΔE

4.56 Given, q is a path function for a thermodynamic charge. Explain under what conditions can it become a state function.

4.57 Explain what is the criterion of spontaneity according to the second law of thermodynamics

4.58 Why is the entropy of a solution higher than that of the pure liquid?

4.59 What is meant by the term 'reversible process' in the thermódynamic sense?

4.60 Why do transformations take place spontaneously in one direction but not in the other?

4.61 For a finite change we use ΔE and ΔH, but not Δq and Δw. Why?

4.62 Does $w = p\Delta v$ mean negative work? Explain.

IV. NUMERICAL PROBLEMS

4.63 When 2.0 g of propane was burnt in excess oxygen in a bomb calorimeter at 300K 105kJ of heat was evolved Calculate ΔH for the reaction at 300K

4.64 The ΔS_{vap} and ΔH_{vap} of liquid hydrogen flouride are 25.7 $JK^{-1}mol^{-1}$ and 7.53 kJ mol^{-1}, respectively Find its boiling point.

4.65 From the following data, calculate the heat of formation of benzene (g)

$$\Delta H_{f(H_2O)} = -284.5 \text{ kJ mol}^{-1}$$

$$\Delta H_{f(CO_2)} = -404.8 \text{ kJ mol}^{-1}$$

and heat of combustion of benzene (g), $\Delta H = -3344.2$ kJ mol^{-1}

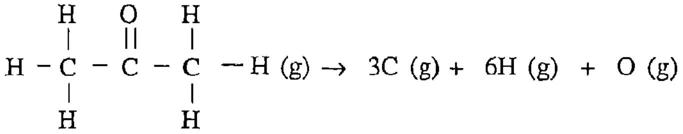
4.66 From the following data at 298K, calculate the bond energy of O-H bond

$$H_2(g) \rightarrow 2H(g); \Delta H_1 = +436.00 \text{ kJmol}^{-1}$$

$$O_2(g) \rightarrow 2O(g); \Delta H_2 = +495.2 \text{ kJmol}^{-1}$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g); \Delta H_3 = -242.0 \text{ kJmol}^{-1}$$

4.67 Calculate the ΔH of the reaction



$$CH_3COCH_3(g) \rightarrow 3C(g) + 6H(g) + O(g)$$

given the average bond energy values of C-H bond, C=O bond and C-C bond are 415.0 kJ mol^{-1}, 707.0 kJ mol^{-1} and 347.0 kJ mol^{-1}, respectively.

4.68 The enthalpy change for the transition of ice to liquid water is 6.0 kJ,mol^{-1} at 273 K. Calculate the entropy change for this process.

4 69 The enthalpy of neutralization

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

is –57 kJ mol^{-1} and enthalpy of formation of water is –286 kJ mol^{-1}. If $\Delta H_f(H^+_{aq})$ is zero, find the value of $\Delta H_{f(OH^-aq)}$

4 70 Calculate the change in Gibbs energy when 1 mole $N_2O_4(g)$ forms 2 moles $NO_2(g)$ under standard conditions at 298K The change of entropy is + 4.8 JK^{-1} mol^{-1} for the reaction Given that $\Delta H^O_{f[N_2O(g)]}$ = + 33 2 kJ mol^{-1} and $\Delta H^O_{f[N_2O_4(g)]}$ = +9 2 kJ mol^{-1} State whether the reaction is spontaneous or not, under the above conditions

4 71 Calculate the standard change in entropy for the reaction

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$$

at 298K. Given that $S^O_{H_2O(l)}$ = 69.9 JK^{-1} mol^{-1}; $S^O_{O_2(g)}$ = 205.1JK^{-1} mol^{-1} and $S^O_{H_2(g)}$ = 130 7 JK^{-1} mol^{-1}.

4 72 Calculate the value of the equilibrium constant of the following reaction at 298K

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \quad \Delta H^0 = +51.88kJ$$

Given that $S^OH_{2(g)}$ = 130 6 JK^{-1} mol^{-1}

$S^O_{I_2(g)}$ = 116.73 JK^{-1} mol^{-1}

$S^O_{HI(g)}$ = 206 27 JK^{-1} mol^{-1}

UNIT 5

Electrochemistry

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer

5.1 Electrolytic conduction is due to the flow of
- (a) ions in a metal
- (b) electrons in a metal
- (c) electrons in a molten electrolyte or its solution
- (d) ions in a molten electrolyte or its solution

5.2 Molar conductivity of Na_2SO_4 solution at infinite dilution λ^{∞}_{m} $(Na_2\,SO_4)$ is given by the expression : $\lambda^{\alpha}_{m}(Na_2SO_4)$ =
- (a) $\lambda^{\infty}(Na^{+}) + \lambda^{\infty}(SO_4^{2-})$
- (b) $2\lambda^{\infty}(Na^{+}) + 2\lambda^{\infty}(SO_4^{2-})$
- (c) $2\lambda^{\infty}(Na^{+}) + \lambda^{\infty}(SO_4^{-2})$
- (d) $\lambda^{\infty}(Na^{+}) + 2\lambda^{\infty}(SO_4^{2-})$

5.3 The correct representation of the galvanic cell corresponding to the reaction

$$2Cr(s) + 3Cd^{2+}(aq) \rightarrow 2Cr^{3+}(aq) + 3Cd(s) \text{ is :}$$

- (a) $Cr^{3+}(aq) \mid Cr(s) \parallel Cd(s) \mid Cd^{2+}(aq)$
- (b) $Cr(s) \mid Cr^{3+}(aq) \parallel Cd^{2+}(aq) \mid Cd(s)$
- (c) $Cd(s) \mid Cd^{2+}(aq) \parallel Cr^{3+}(aq) \mid Cr(s)$
- (d) $Cd^{2+}(aq) \mid Cd(s) \parallel Cr(s) \mid Cr^{3+}(aq)$

5.4 Unit of molar conductivity is :
- (a) $S\ mol^{-1}$
- (b) $S\ cm^2\ mol$
- (c) $S\ cm^2\ mol^{-1}$
- (d) $S\ mol$

5.5 When 965 coulombs of charge is passed through an aqueous $AgNO_3$ solution, the amount of Ag deposited at the cathode is

(a) 1080
(b) 108
(c) 10.8
(d) 1.08

(Given, atomic mass of Ag is 108 g mol^{-1})

5.6 For the cell reaction

$$Mg(s) + 2Ag^+(aq) \rightarrow 2\ Ag(s) + Mg^{2+}\ (aq)$$

the cell potential is expressed as .

(a) $E = E^o + \frac{0.0592}{2} \log \frac{[Ag^+]^2}{[Mg^{2+}]}$

(b) $E = E^o + \frac{0.0592}{2} \log \frac{[Ag^+]}{[Mg^{2+}]}$

(c) $E = E^o + \frac{0.0592}{2} \log \frac{[Mg^{2+}]}{[Ag^+]^2}$

(d) $E = E^o + \frac{0.0592}{2} \log \frac{[Mg^{2+}]^2}{[Ag^+]}$

5.7 If a solution is placed between two parallel electrodes having a cross-sectional area A cm^2 and distance l cm apart, the equation that holds is

(a) $R = \rho \frac{l}{A}$

(b) $\rho = \frac{Rl}{A}$

(c) $R = \frac{\rho A}{l}$

(d) $\rho = \frac{Al}{R}$

where ρ is the resistivity (in ohm cm) and R the resistance of the solution (in ohm)

5.8 Given the reaction $Al^{3+} + 3e^- \rightarrow Al$ Production of 1 mol of Al will require a charge of

(a) 32166 C

(b) 96500 C
(c) 193000 C
(d) 289500 C

5.9 When the same quantity of electricity is passed through solutions of different electrolytes for the same duration of time, the reaction at the electrode involves quantities of electrolytes :
(a) inversely proportional to their equivalent masses
(b) directly proportional to their equivalent masses
(c) inversely proportional to their molecular masses
(d) directly proportional to their molecular masses.

5.10 Of the following combinations, predict the one that could lead to a reaction. Use the information provided below :

Fe^{3+} (aq) e^- → Fe^{2+} (aq), $E^0 = +0.77V$

$Cl_2(g) + 2e^- \rightarrow 2Cl^-$ (aq), $E^0 = +1.36V$

(a) Fe^{2+} (aq) + Cl_2 (g)
(b) Fe^{3+} (aq) + Cl_2 (g)
(c) Fe^{2+} (aq) + Cl^- (aq)
(d) Fe^{3+} (aq) + Cl^- (aq)

5.11 Electrical conductivity is affected by :
(a) the interionic attraction (i.e. solute-solute interaction)
(b) the solvation of ions (i.e. solute-solvent interaction)
(c) the viscosity of the solvent (i.e. solvent-solvent interaction)
(d) all the three (a, b, c) above.

5.12 Electrochemical reactions in which chemical changes result due to the passage of electric current :
(a) are observed in cells or batteries
(b) are spontaneous reactions
(c) can enable the system to do work, e.g. it can run a motor
(d) lead to work being done on the system.

5.13 A galvanic cell involves the following electrode reaction :

Zn^{2+} (aq) + $2e^-$ → Zn(s) $E^0 = -0.76$ V

Cd^{2+} (aq) + 2e → Cd(s) $E^0 = -0.40$ V

The cell potential of the above cell is :
(a) −1.16 V
(b) −0.36 V
(c) +0.36 V
(d) +1.16 V

5.14 The cell constant of a given cell is 0.367 cm^{-1}. The resistance of a solution placed in this cell is measured to be 31.6 ohm. The conductivity of the solution (in S cm^{-1}) is :
(a) 11.6

(b) 031
(c) 86 15
(d) 0116

5.15 Equivalent conductivity of an electrolytic solution is expressed as .

(a) $\dfrac{\text{conductivity}}{\text{conc. in equivalents / litre}}$

(b) $\dfrac{\text{conductivity}}{\text{conc. in g / litre}}$

(c) $\dfrac{\text{conductivity}}{\text{conc. in g moles / litre}}$

(d) $\dfrac{\text{conductance}}{\text{conc. in g equivalents / litre}}$

(B) Completion Type

Complete the following .

5.16 Electrical cells that convert the energy of combustion of fuels such as CO, CH_4, H_2 directly into electrical energy are called ______ .

5.17 Interionic attraction is one factor that affects the electrical conductivity of solution of electrolytes. Two other factors which affect the electrical conductivity are ____(i)____, and ____(ii)____ .

5.18 At infinite dilution molar conductivity of an electrolyte can be expressed as the sum of the contributions from its____(i)____ . This is called ____(ii)____ law.

5.19 Equivalent conductivity of an electrolyte is related to conductivity by the expression : equivalent conductivity = conductivity ÷ ______ .

5.20 Arrhenius proposed that the molar conductivity of an electrolyte is related to its degree of dissociation by the relation _______ .

5.21 The arrangement of metals in order of decreasing tendency to ____(i)____ electrons provides the activity series or the ____(ii)____ of the metals.

5.22 As iron corrodes at a spot of an iron object, oxidation occurs and that spot behaves as _______ .

5.23 Use of zinc coating to protect iron from corrosion is called _______ .

5.24 Reciprocal of resistance is called ____(i)____, and the unit used for this quantity is ____(ii)____.

5.25 If the value of $\lambda^{\infty}_{m}(HCl)$, $\lambda^{\infty}_{m}(NaCl)$ and $\lambda^{\infty}_{m}(CH_3COONa)$ are 426 ohm^{-1} cm^2 mol^{-1}, 126 ohm^{-1} cm^2 mol^{-1} and 91 ohm^{-1} cm^2 mol^{-1}, then the value of $\lambda^{\infty}_{m}(CH_3COOH)$ is _______ ohm^{-1} cm^2 mol^{-1}.

(C) True and False Type

Classify the following statements as true (T) or false(F) :

5.26 In the galvanic cell

$$Zn(s)\ Zn^{2+}(aq)\ ||\ Cu^{2+}(aq)\ |\ Cu(s)$$

the electrons flow from Cu to Zn electrode

5.27 Secondary cells are those which can be recharged by passing current through them.

5.28 Electrical cells that convert the energy from the combustion of fuels like H_2, CO, CH_4 directly into electrical energy are called fuel cells.

5.29 During an electrolytic process, current that is to be passed to evolve 35.5g of chlorine from the electrolyte is one faraday.

5.30 The reaction that takes place at an anode is reduction.

5.31 For a redox process if ΔG is positive, change can still be brought about if the surroundings do electrical work on the system, as in an electrolysis process

5.32 In an electrolytic process electrical current is used to carry out a chemical reaction, while in a galvanic cell a chemical reaction generates an electrical current.

5.33 When molten sodium chloride is electrolysed, sodium and chlorine are formed at the electrodes; while when a concentrated aqueous sodium chloride solution is electrolysed, hydrogen and chlorine gases are evolved at the electrodes.

5.34 A lead storage battery is a primary cell.

(D) Matching Type

Match the items given in List A with relevant answers given in List B, by indicating the serial number of the item of List A against that of List B.

5.35

LIST A *Type of Cell*	LIST B *Same as*
(a) galvanic cell	(i) dry cell
(b) primary cell	(ii) fuel cell
(c) secondary cell	(iii) voltaic cell
	(iv) nickel cadmium cell

5.36

LIST A *Equation*	LIST B *Represents*
(a) $\lambda_m^\infty = \nu_+ \lambda_+^\infty + \nu_- \lambda_-^\infty$	(i) Nernst equation
(b) $V = IR$	(ii) Kohlrausch's law
(c) $E_{M^{n+}/M} = E^0_{M^{n+}/M} + \frac{RT}{nF} \ln\left[M^{n+}\right]$	(iii) Ohm's law
	(iv) Faraday's law

5.37

LIST A *Unit*	LIST B *Represents*
(a) S cm^2 mol^{-1}	(i) electrical conductance
(b) S	(ii) molar conductivity
(c) S cm^{-1}	(iii) resistance
	(iv) conductivity
	(v) resistivity

II. SHORT-ANSWER TYPE ITEMS

5.38 What are the factors which affect the electrical conductivity of electrolytes and their solutions?

5.39 What is meant by the term 'resistivity'? Derive a relation between resistivity and resistance.

5.40 Differentiate between a primary cell and a secondary cell.

5.41 What are fuel cells?

5.42 What is galvanisation? How does this process work?

5.43 How can you determine the degree of dissociation of a weak electroyte from its molar conductivity measurements?

5.44 Can the Nernst equation be used to calculate the EMF of a cell at different temperatures?

5.45 Why is there a steep rise in the molar conductivity of a weak electrolyte, as its concentration decreases?

5.46 Is the Leclanche cell a primary cell, or is it a secondary cell? How does it work? Explain with suitable equations.

5.47 Do the molar conductivities of strong and weak electrolytes vary in the same way with concentration?

5.48 Differentiate between electrode potential and cell potential

5.49 Predict the products of electrolysis of the following :

(a) molten sodium chloride with platinum electrodes
(b) aqueous solution of sodium chloride with platinum electrodes
(c) aqueous solution of silver nitrate with silver electrodes
(d) aqueous solution of silver nitrate with platinum electrodes

5.50 How many coulombs of electricity would be required to carry out the following changes?

(a) 1 mol Sn^{2+} to Sn^{4+}
(b) 1 mol Fe^{3+} to fe^{2+}
(c) $\frac{1}{2}$ mol Br_2 to Br^-
(d) 1 mol $Cr_2O_7^{2-}$ to Cr^{3+}

5.51 Using the information given below, arrange K, Zn^{2+}, Cl_2, in the increasing order of their oxidizing power Justify your answer.

$K^+ (aq) + e^- \rightarrow K(s)$ $E^0 = -2.93$ V
$Zn^{2+} (aq) + 2e^- \rightarrow Zn(s)$ $E^0 = -0.76$ V
$Cl_2 (g) + 2e^- \rightarrow 2Cl^- (aq)$ $E^0 = +1.36$ V

5.52 Using the data given below, arrange Fe^{3+}, Al, Br in the increasing order of their reducing power. Justify your answer.

$Fe^{3+} (aq) + e^- \rightarrow Fe^{2+} (aq)$ $E^0 = +0.77V$
$Al^{3+} (aq) + 3e^- \rightarrow Al (s)$ $E^0 = -1.66V$
$Br_2 (aq) + 2e^- \rightarrow 2Br^-(aq)$ $E^0 = +1.08V$

III. LONG-ANSWER TYPE ITEMS

5.53 Describe a method for measurement of electrolytic conductivity and explain the principle behind it

5.54 Differentiate between strong and weak electrolytes on the basis of the variation of the conductivities of their aqueous solutions with change in concentration.

5.55 Explain the mechanism behind corrosion of metals. How can this be prevented? How is this specifically done for iron?

5.56 Define the terms conductance, conductivity, equivalent conductivity, molar conductivity and molar conductivity at infinite dilution.

5.57 With the help of the data given below, explain why zinc liberates hydrogen from mineral acids, while copper does not.

Element	Electrode Reaction			E^O_{298} (volts)
Zn	$Zn^{2+} + 2e^-$	$\rightarrow$	Zn (s)	− 0.76
H_2	$2H^+ + 2e^-$	$\rightarrow$	H_2 (g)	0.00
Cu	Cu^{2+} (aq) + $2e^-$	$\rightarrow$	Cu(s)	+ 0.34

5.58 A metal X is a stronger oxidising agent than another metal Y. A cell is set up by combining the electrodes X^{2+}/X and Y^{2+}/Y. What will be the direction of flow of current in the external circuit of this cell?

5.59 Equimolar solutions of two electrolytes A and B were diluted 4 times each. While the equivalent conductance increased by 10% in case of A, it increased by 200% in case of B. Comment on the nature of the electrolytes.

IV. NUMERICAL PROBLEMS

5.60 What current strength in amperes would be required to deposit 1g of Cu from a solution of $CuSO_4$ in 2 hours. (Given atomic mass of Cu is 63.5 g mol^{-1})

5.61 Determine the cell constant of a cell, when an aqueous solution of NaCl in this cell gives a resistance value of 247.8 ohms. The conductivity of the above solution is 92 S cm^{-1}.

5.62 Calculate the molar conductivity at infinite dilution for NH_4OH when the corresponding values of NH_4Cl, NaOH and NaCl are 150, 248 1 and 126 4 S cm^2 mol^{-1}, respectively.

5 63 Calculate (a) the degree of dissociation, and (b) the dissociation constant of 0.01M CH_3COOH solution; given conductivity of CH_3COOH is 1 65 × 10^{-4} S cm^{-1} and molar conductivity at infinite dilution i e

λ_m^α (CH_3COOH) is 390 6 S cm^2 mol^{-1}.

5.64 Calculate the standard electrode potential $E^0_{Zn|Zn^{2+}}$ using the information provided below

Cd(s) | Cd^{2+} (aq, c = 1M) || H^+ (aq, c = 1M) | H_2(g, 1 atm), Pt E^0_{cell} = + 0 40V

Zn(s) | Zn^{2+} (c = 1M) || Cd^{2+} (c = 1 M) | Cd (s) E^0_{cell} = +0.36V

5.65 Calculate the cell potential of the cell

Ca(s) | Ca^{2+} (aq, c = 0.02M) || Cu^{2+} (aq, c = 0 01M) | Cu(s)

Given .

$E^0_{Ca|Ca^{2+}} = -2\ 87V$, $E^0_{Cu|Cu^{2+}} = +\ 0.34$ V

5.66 Calculate the standard potential of the cell

Cd (s) | Cd^{2+} (aq, c = 1M) || H^+ (aq,c = 1m) | H_2(g, 1 atm), Pt

using the following information ·

Zn (s) | Zn^{2+} (aq, c = 1M) || Cd^{2+} (aq, c = 1M) | Cd(s),

E^0_{cell} = + 0.36 V and $E^0_{Zn|Zn^{2+}(aq)}$ = – 0 76 V.

5 67 When combined in a cell with another electrode, the electrode potential of Zn(s) | Zn^{2+} (aq, c = 0 02 M) is found to be – 0.76V. Calculate the corresponding standard electrode potential value.

5.68 There is an aqueous $AgNO_3$ cell in series with one in which aqueous NaCl is being electrolyzed. If 0.0198g Ag is plated out in the cathode of the first cell, how many moles of H_2 will be liberated at the cathode of the second cell? (In series means, the two cells are so connected that the anode of one is directly connected to the cathode of the other.) (Given, atomic mass of Ag is 108 g mol^{-1})

5.69 Given a galvanic cell in which the overall reaction is $Zn(s) + Cl_2(g) \rightarrow Zn^{2+} + 2Cl^-$. If the cell uses 3g Zn in the reaction, how long could it deliver 0.20A to outside? (Given atomic mass of Zn is 65 g mol^{-1})

5 70 The E^0 for the cell :

Ni(s) | Ni^{2+} (aq) || Ag^+ (aq) | Ag(s)

is + 1.05V Calculate ΔG^0 for this cell reaction

5.71 A conductivity cell was filled with 0.1M NaCl solution at 25°C. Its resistance was found to be 176.6 ohm. The conductivity of this solution is 9.2×10^{-3} S cm^{-1}. The cross-sectional area of the electrodes used was 4 cm^2. What must have been the distance between the electrodes?

5.72 E^0 of the following cell is + 0.828V.

$$Pt\ (s)\ |\ H_2(g)\ |\ OH^-\ (aq)\ ||\ H^+\ (aq)\ |\ H_2(g)\ |\ Pt(s)$$

(a) Identify the anode and the cathode in the cell and write the respective half cell reaction.

(b) Write the cell reaction.

(c) Calculate the equilibrium constant K_c for the cell reaction

5.73 The resistance of a 0.01M NH_4OH solution is 4×10^3 ohm in a cell where cell constant is 0.48cm^{-1}. Given, $\lambda^\infty_{NH_4^+}$ = 73.4 S cm^2 mol^{-1} and λ^∞_{OH} = 197.6 S cm^2 mol^{-1} Calculate (a) the degree of dissociation (α), (b) the per cent dissociation of NH_4OH at this concentration.

UNIT 6

Chemical Kinetics

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer

6.1 The unit for rate of a reaction is expressed as :

- (a) L mol^{-1}
- (b) mol^{-1} L s^{-1}
- (c) mol $L^{-1}s^{-1}$
- (d) mol^{-1} Ls

6.2 For the following reaction :

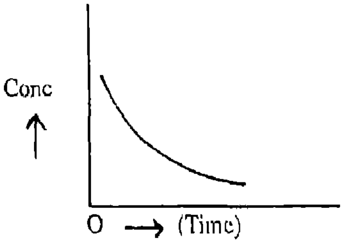
$$2N_2O_5(g) \rightarrow 4\ NO_2(g) + O_2(g)$$

the expression for the rate of reaction is :

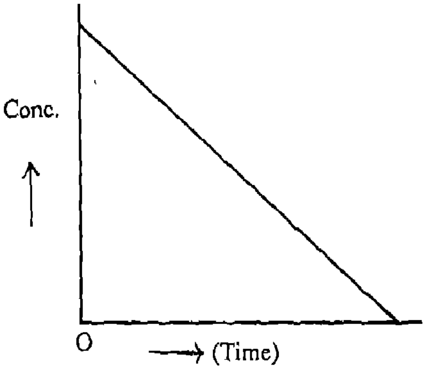
- (a) $\frac{d[O_2]}{dt} = \frac{d[NO_2]}{dt}$
- (b) $\frac{d[O_2]}{dt} = \frac{d[N_2O_5]}{dt}$
- (c) $\frac{d[N_2O_5]}{dt} = \frac{1}{2}\frac{d[NO_2]}{dt}$
- (d) $\frac{d[O_2]}{dt} = \frac{1}{4}\frac{d[NO_2]}{dt}$

6.3 The reaction A → B is first order with respect to A. If the concentration of A is plotted against time, the nature of the curve obtained will be as shown below:

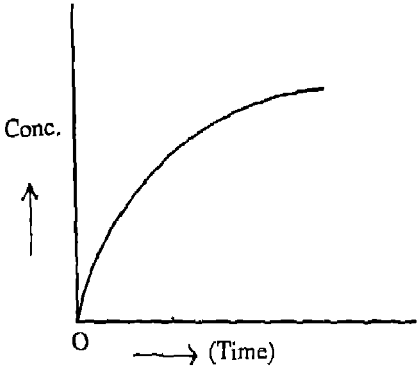
(a)



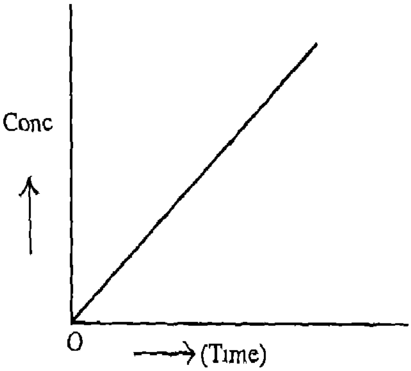
(b)



(c)



(d)



6.4 The rate of a reaction is generally

(a) independent of concentration of reactants but dependent on reaction temperature
(b) independent of reaction temperature but dependent on concentration of reactants
(c) independent of both concentration of reactants and reaction temperature
(d) dependent both on concentration of reactants and reaction temperature.

6.5 The half life of a first order reaction depends :

(a) only on the rate constant but is independent of the initial concentration
(b) both on the rate constant and the initial concentration
(c) neither on the rate constant nor on the initial concentration
(d) only on the initial concentration but is independent of the rate constant.

6.6 Radioactive decay is of :

(a) zero order
(b) fractional order
(c) first order
(d) second order.

6.7 The reaction $N_2O_5(\text{soln}) \rightarrow 2NO_2(\text{soln}) + \frac{1}{2}O_2(g)$, is found to be first order with respect to N_2O_5. Given that the first order rate constant is $6.2 \times 10^{-4}\ s^{-1}$, the rate of the reaction when $[N_2O_5]$ is 1.25, mol L^{-1} is :

(a) 1.55×10^{-4} mol L^{-1} s^{-1}
(b) 7.75×10^{-4} mol L^{-1} s^{-1}
(c) 3.10×10^{-4} mol L^{-1} s^{-1}
(d) 15.50×10^{-4} mol L^{-1} s^{-1}

6.8 The following table represents the time required for 0.1g of zinc to be completely reacted by different solutions of hydrochloric acid :

Solution No.	A	B	C	D	E
Time required (min)	20	25	10	40	50

The concentration of the acid solutions decreases in the order :

(a) BACDE
(b) ACBDE
(c) EDBAC
(d) CABDE

6.9 On doubling the concentration of a reactant A in a reaction mixture, the rate increases 8 times. Mathematically, the rate expression is .

(a) k [A]
(b) k $[A]^2$
(c) k $[A]^3$
(d) k $[A]^0$

6.10 For a hypothetical reaction $A + 2B \rightarrow C$ it is found that the rate = k [A] [B]. The most likely rate determining (slow) step for this reaction will be :

(a) $A + B \rightarrow AB$

(b) $2A \rightarrow A_2$
(c) $2B \rightarrow B_2$
(d) $A + 2B \rightarrow C$

6.11 64 mg of a radioactive isotope decayed to half of its initial amount after 2 years The amount of the same after 8 years in mg will be :
(a) 1
(b) 4
(c) 8
(d) 16

6.12 The average rates for a reaction $A \rightarrow C$ at different times are as follows :

Time (s)	5	20	34	60
Rate ($mol\ L^{-1} s^{-1} \times 10^{-2}$)	2.8	2.8	2.82	2.78

The order of reaction is :
(a) 0
(b) 1
(c) 2
(d) 3.

6.13 With the reaction $aA + bB \rightarrow$ Products, it was found that (a) when the initial concentration of A was doubled and that of B held constant, the initial rate was doubled; (b) when the initial concentration of B was doubled, and that of A was kept constant, the initial rate was quadrupled. On the basis of this data :

(i) The order of reaction with respect to A is :
  (a) 1
  (b) 2
  (c) 3
  (d) 0

(ii) The order of reaction with respect to B is .
  (a) 1
  (b) 2
  (c) 3
  (d) o

(iii) Overall order of reaction is .
  (a) 1
  (b) 2
  (c) 3
  (d) a + b

6.14 Given the following data : $D + E \rightarrow F$

S.No	[D] mol L^{-1}	[E] mol L^{-1}	Initial rate mol L^{-1} h^{-1}
1.	0.35	1.28	0.032
2.	0.35	0.64	0.008
3.	0.70	0.64	0.016.

(i) The order of the reaction with respect to D is :

- (a) 0
- (b) 1
- (c) 2
- (d) 3

(ii) The order of the reaction with respect to E is :

- (a) 0
- (b) 1
- (c) 2
- (d) 3

(iii) The overall order of the reaction is .

- (a) 1
- (b) 2
- (c) 3
- (d) 4

(iv) The value of the specific rate constant is :

- (a) 0.56
- (b) 0 056
- (c) 0 028
- (d) 0 28

(v) The unit for the rate constant is :

- (a) mol^{-1} L h^{-1}
- (b) mol^{-2} L^2 h^{-1}
- (c) mol^2 L^{-2} h^{-1}
- (d) h^{-1}

6 15 For the reaction A + B + C → Products, it was observed that : (i) when the concentration of A was doubled, the initial rate doubled, (ii) when the concentration of B was doubled, the initial rate remained unchanged, (iii) when the concentration of C was doubled, the initial rate increased by four times (For each change, the concentration of the other reactants was kept constant)

(i) The order of the reaction with respect to A is.

- (a) 0
- (b) 1
- (c) 2
- (d) 3

(ii) The order of the reaction with respect to B is.

- (a) 0
- (b) 1
- (c) 2
- (d) 3

(iii) The order of the reaction with respect to C is :

- (a) 0
- (b) 1
- (c) 2
- (d) 3

(iv) Overall reaction rate is .
   (a) 0
   (b) 1
   (c) 2
   (d) 3

(B) Completion Type

Complete the following:

6.16 For the decomposition reaction $2O_3 \rightarrow 3O_2$, the rate of reaction in terms of ozone is written as :____(i)____, and in terms of oxygen is written as___(ii)___.

6.17 In the formation of ammonia given by the equation $N_2 + 3H_2 \rightleftharpoons 2NH_3$, the concentration of ammonia in mol L^{-1}, in time 100 s, is X mol L^{-1} and in time 150 s is Y mol L^{-1}. The rate of formation of ammonia, i.e., $\frac{Y-X}{50s}$ mol L^{-1} is called the ______ rate.

6.18 The rate expression for a reaction $2A + 3B + C \rightarrow$ Product, is expressed as : rate = $k\,[A]\,[B]^2\,[C]^0$. The overall order of reaction is ______.

6.19 For a reaction $2A + B \rightarrow C + D$ the initial rate is doubled as the concentration of A is doubled. The order of reaction with respect to A is ________.

6.20 The unit of rate constant for a first order reaction is ________, while that for a zero order reaction it is ______.

6.21 The half life period $\left(t_{\frac{1}{2}}\right)$ for a first order reaction is represented by the expression $\left(t_{\frac{1}{2}}\right)$ = __________ ÷ k (where k is the rate constant.)

6.22 On increasing temperature, the value of energy of activation for a reaction ________.

6.23 On the basis of the kinetic theory of gases, the number of collisions between molecules having energy equal to or greater than E_a (energy of activation) is proportional to the expression _______.

6.24 In certain photochemical reactions a molecule absorbs light and transfers its extra energy to another molecule, which then undergoes a reaction. Such a process is called ______.

6.25 A photon of red light is ______energetic than photon of blue light.

6.26 For the reaction $NO_2(g) + CO(g) \rightarrow CO_2(g) + NO(g)$, the rate expression is : rate = $k\,[NO_2]^2$. The reactant(s) of the slow elementary step is/are ______.

6.27 For a reaction $2A \rightarrow B$, the plot of log [A] versus time is a straight line with a negative slope The order of reaction with respect to A is ________

6.28 The half life period of a first order reaction depends only on the ________ .

(C) True or False Type

Classify the following statements as true (T) or false (F) :

6.29 Even if one of the reactants or a catalyst used in the reaction is a solid, surface area does not affect a reaction rate.

6.30 For a first order reaction, the half life period changes with concentration of the reactant.

6.31 Radioactive decay is an example of a process that obeys a first order kinetics

6.32 The plot of log [C] against time gives a straight line with a negative slope for a first order reaction, where C stands for concentration of the species with respect to which the reaction is first order

6.33 Half life period of a first order reaction depends on the values of both the rate constant and the initial concentration.

6.34 The order of a reaction is usually determined from the balanced chemical equation

6.35 For a reaction, the energy of activation changes with change in temperature

6.36 In the reaction between $H_2(g)$ and $Cl_2(g)$, the absorption of sunlight causes the decomposition of chlorine molecules into chlorine atoms.

6.37 The exponents of the concentration terms in the rate law are always the same as the respective coefficients in the balanced chemical equation

(D) Matching Type

Match the items given in List A with relevant answers in List B by indicating the serial number of the item of List A against that of List B.

6.38

LIST A *Expression/Equation*	LIST B *Stands for*
(a) $\frac{\Delta[O_2]}{\Delta t}$	(i) instantaneous rate
(b) $t_{\frac{1}{2}} = \frac{0.693}{k}$	(ii) rate law
(c) $k = Ae^{-Ea/RT}$	(iii) average rate
(d) $\left[\frac{\Delta[O_2]}{\Delta t}\right]_{\Delta t \rightarrow O}$	(iv) Arrhenius' equation
	(v) half life period of a first order process

6.39

	LIST A *Method for measuring reaction rate*		LIST B *Procedure involved/Method used for*
(a)	method using measurement of change in pressure accompanying a reaction, at different times	(i)	measuring the rate at the beginning of the reaction so that concentration of reactants have not changed appreciably
(b)	initial rate method	(ii)	method utilising calculus
(c)	integrated rate law method	(iii)	reaction involving gaseous species only
		(iv)	plotting logarithm of concentration against time

II SHORT-ANSWER TYPE ITEMS

6.40 Differentiate between order and molecularity of a reaction

6.41 What is Arrhenius' equation? What do the different terms stand for?

6.42 Express the equation $k = Ae^{-E_a/RT}$ in the form of the equation of a straight line

6.43 How will you find out the rate of a first order reaction?

6.44 Express the rate of the following reaction

$$N_2(g) + 3H_2(g) \rightarrow 2\,NH_3(g)$$

in terms of change in concentration of ·

N_2, H_2 and NH_3

6.45 Differentiate between average rate and instantaneous rate of a reaction.

6.46 The reaction $2NO_2 + F_2 \rightarrow 2NO_2F$ involves the following two steps :

$$NO_2 + NO_2 \rightleftharpoons N_2O_4 \quad \text{(fast)}$$

$$N_2O_4 + F_2 \rightarrow 2NO_2F \text{ (slow)}$$

The rate law expression is :

Rate = $k\,[NO_2]^2\,[F_2]$.

(a) What is the overall order of the reaction?

(b) What is the rate determining step?

6.47 What is the principle behind the initial rate method in chemical kinetics?

6.48 What is meant by the half life period of a process?

6.49 Derive the expression $t_{\frac{1}{2}} = \frac{0.693}{k}$, where $t_{\frac{1}{2}}$ is the half life period of a first order reaction and k is the rate constant of that reaction

6.50 What is the order of a nuclear disintegration processes?

6.51 Why do reaction rates depend on temperature?

6.52 What are photochemical reactions?

6.53 Photon of red light is less energetic than that of violet light. Why?

6.54 What is photosensitisation?

6.55 Give three examples of the role of photochemical reactions in our daily life

6.56 Define each of the following terms

(a) chemical kinetics
(b) reaction rate
(c) rate law
(d) rate constant
(e) order of reaction
(f) first order reactions
(g) second order reactions
(h) zero order reactions
(i) half life
(j) activation energy
(k) chain initiating step
(l) chain propagating step
(m) chain terminating step

III. LONG-ANSWER TYPE ITEMS

6.57 What are the main methods used for determining the orders of reactions? Discuss briefly.

6.58 Show that the plot of the logarithm of concentration against time for a first order reaction is a straight line.

6.59 Discuss the effect of temperature on reaction rates. Show, using Arrhenius' equation that, a plot of $\log_{10} k$ against $\frac{1}{T}$ is a straight line.

(k is the rate constant of the reaction and T is the temperature in Kelvin.)
What information can be obtained from the slope of this curve?

6.60 For the chemical reaction

$$NO_2(g) + CO(g) \rightarrow CO_2(g) + NO(g)$$

the rate expression is, rate = $k\,[NO_2]^2$.

What information does the above rate law provide towards the mechanism of the reaction and why?

6.61 (i) What do you understand by a photochemical reaction?
(ii) What is meant by photosensitisation?
(iii) Why do you think that reaction that are initiated by, say blue light, cannot be initiated by red light?
(iv) What are photochemical chain reactions?
(v) State some of the natural processes which are examples of photochemical reactions.

IV NUMERICAL PROBLEMS

6.62 For the reaction A $\rightarrow$ B + C, the following data are given

Run No.	Initial [A] mol L^{-1}	Initial $-\frac{d[A]}{dt}$ mol L^{-1} min^{-1}
1.	1.96×10^{-2}	3.14×10^{-4}
2.	2.57×10^{-2}	4.11×10^{-4}

Calculate (i) the order of the reaction,
(ii) the rate constant

6.63 Given the reaction A + B $\rightarrow$ C. The rate constant k_1 at 673K for the reaction is 0.0234 $M^{-1}s^{-1}$and the rate constant k_2 at 773K is 0.750 $M^{-1}s^{-1}$ Calculate the activation energy for this reaction (Given R = 8.31 $Jmol^{-1}K^{-1}$.)

6.64 For the reaction A $\rightarrow$ 2B + C, given the following data.

Time(s)	Concentration of A(mol L^{-1})
0	0.100
600	0.0603
1200	0.0363

show that the order of the reaction is 1.

6.65 For the reaction 2A$\rightarrow$ 2B + C the rate constant is 1.72×10^{-5} s^{-1} at 298 K and 2.40×10^{-3} s^{-1} at 338 K, respectively Calculate the :
(i) activation energy
(ii) the Arrhenius' constant
(iii) rate at 318 K
(Given R = 8.341 $Jmol^{-1}K^{-1}$)

6.66 Time required for a particular reaction to be half completed is 693s Calculate the time required for 90% completion of this reaction.

6.67 Show that for a first order reaction the time required for 75% completion of the reaction is twice the time required for 50% completion of the reaction.

6.68 In a particular reduction reaction, a solution that is initially 0.24 M is reduced to 0.12 M in 10h and 0.06 M in 20 h (i) What is the order of the reaction? (ii) What is the rate constant?

6.69 The gaseous reaction

A(g) $\rightarrow$ 2B(g) + C(g)

is observed to be of the first order On starting with pure A, it is found that at the end of 10 min, the total pressure of the system is 176 mm Hg and after a long time it is 270 mm Hg. Calculate·

(a) the initial pressure of A, (b) the partial pressure of A after 10 min, and (c) the rate constant of the reaction.

UNIT 7

Organic Chemistry Based on Functional Group I

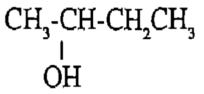
I OBJECTIVE TYPE ITEMS

(A) **Multiple Choice**

Write the correct answer:

7.1 The IUPAC name for CHI_3 is .
- (a) Iodoform
- (b) Methyltriiodide
- (c) 1,1,1-triiodomethane
- (d) 1,2,3,-triiodomethane.

7.2 The IUPAC name for



$CH_3\text{-}\underset{\overset{|}{OH}}{CH}\text{-}CH_2CH_3$ is ·
- (a) Sec-Butyl alcohol
- (b) 2-Butanol
- (c) 2-Hydroxy butane
- (d) 2-Butyl alcohol

7.3 The reaction between ethyne and excess chlorine involves :
- (a) a substitution reaction
- (b) a simple addition as per Markownikoff's rule
- (c) a simple addition without the need of referring to Markownikoff's rule
- (d) Kharasch effect.

7.4 Fluoroarenes are obtained by decomposing the corresponding diazonium tetrafluoroborate This reaction is known as .
- (a) Sandmeyer's reaction
- (b) Kolbe's reaction
- (c) Wurtz reaction
- (d) Reimer-Tiemann reaction

7.5 Which of the following compounds has a secondary carbon atom?
(a) Butan-1-ol
(b) Propan-2-ol
(c) 2-Methylpropan-2-ol
(d) n-Propanol

7.6 Of the following arrangements, identify the one which is correct in terms of boiling points ·
(a) $C_2H_5I > C_2H_5Br > C_2H_5Cl$
(b) $CH_3I < C_2H_5Cl < C_3H_7I$
(c) $C_2H_5F > C_2H_5Cl > C_2H_5Br$
(d) $CH_3I < CH_3Br < CH_3Cl$.

7.7 Iodoform test is answered by :
(a) Ethanol
(b) 2-propanol
(c) Propan-2-one
(d) All of the above

7 8 2-propanol can be obtained from
(a) C_2H_5MgBr and HCHO
(b) any Grignard reagent and HCHO
(c) Ethanal and CH_3MgBr
(d) any Grignard reagent and methanal.

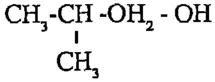
7 9 Aspirin is the name of the compound with the IUPAC nomenclature :
(a) 3-Acetoxy benzoic acid
(b) O-Acetyl benzoic acid
(c) p-Hydroxy benzoic acid
(d) 2-Acetoxy benzoic acid.

7.10 Rectified spirit is :
(a) 95% methanol
(b) 95% ethanol
(c) 100% methanol
(d) 100% ethanol.

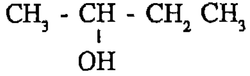
7 11 The formula for the compound commonly known as Gammexane, is.
(a) $C_6H_6Cl_6$
(b) CHI_3
(c) $CHCl_3$
(d) CCl_2F_2

7 12 The IUPAC name of glycerol is
(a) 2-Methyl-2-propanol
(b) 1,2-Ethanediol
(c) 2-Methyl-1-propanol
(d) 1 2,3-Propanetriol

7.13 Which of the following represents the formula of a tertiary alcohol?

(a) 
$CH_3\text{-}\underset{\underset{CH_3}{|}}{CH}\text{-}OH_2 - OH$

(b) $CH_2\ OH\ CHOH\ CH_2\ OH$

(c) 
$CH_3 - \underset{\underset{OH}{|}}{CH} - CH_2\ CH_3$

(d) $(CH_3)_3\ C - OH$

7 14 Tertiary butyl alcohol has the IUPAC name :

(a) 1-Butanol
(b) 2-Butanol
(c) 2-Methyl-1-propanol
(d) 2-Methyl-2-propanol

7.15 When 1-Bromobutane is treated with alcoholic KOH solution, the formation of the product takes place by ·

(a) dehydrogenation
(b) dehydrohalogenation
(c) dehydration
(d) decarboxylation.

7 16 When trichloromethane is slowly oxidised by air in the presence of light, the product formed is ·

(a) carbondioxide
(b) phosphine
(c) phosgene
(d) diethylcarbonate.

7 17 When 1-Bromopropane is converted into propene in the presence of alcoholic KOH solution, the reaction involves elimination of a molecule of

(a) HBr
(b) H_2
(c) H_2O
(d) Br_2

7.18 Trichloromethane when heated with which of the following metal powder is converted to acetylene?

(a) Mg
(b) Na
(c) Ag
(d) Ca

7 19 Identify from the following, that group, each member of which gives positive iodoform test:

(a) methanol, ethanol, propanone
(b) ethanol, 2-propanol, methanol

(c) ethanol, 2-propanol, propanone
(d) methanol, ethanol, 1-propanol

7.20 A tertiary alcohol is obtained ·
(a) by the reaction of an aldehyde and a Grignard reagent
(b) when an aldehyde is reduced by $LiAlH_4$
(c) by the reaction of a ketone and a Grignard reagent
(d) when a ketone is reduced with $LiAlH_4$

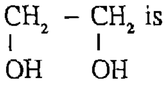
7.21 2-propanol is best converted to 2-propanone by the method of
(a) hydration
(b) dehydration
(c) reduction
(d) oxidation

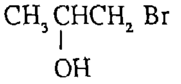
7.22 Primary, secondary and tertiary alcohols are best distinguished by reaction involving
(a) oxidation
(b) reduction
(c) dehydration
(d) esterification

7.23 Which of the following is most resistant to oxidation?
(a) 1-Butanol
(b) 2-Butanol
(c) 2-Methyl 1-propanol
(d) 2-Methyl 2-propanol

(B) Completion Type

Complete the following·

7.24 The IUPAC name of

$\underset{OH}{CH_2} - \underset{OH}{CH_2}$
is ________________________.

7.25 The IUPAC name of

$CH_3\underset{OH}{CH}CH_2Br$
is ______________________

7.26 The IUPAC name for CCl_2F_2 is ____________________

7.27 Presence of CCl_2F_2 in the atmosphere has been linked to the destruction of the ________________________ layer.

7.28 The trade name for $C_6H_6Cl_6$ is ____________________

7.29 CHI_3 is used as an ________________________

7.30 Slow oxidation of ________________________ in prsence of light yeilds phosgene

7.31 Esters of ________________________ are known as glycerides.

7.32 In the presence of peroxides such as benzoyl peroxide, the addition of HBr to unsymmetrical olefins take place contrary to Markownikoff's rule. This is called the ____(i)____ or ____(ii)____ .

7.33 Glycerol is used to manufacture a polyester called________

7.34 The chemical name of wood spirit is________.

7.35 $C_6H_6 + 3Cl_2 \xrightarrow[light]{uv}$ ____(i)____ This product is used as a____(ii)____.

7.36 $C_6H_6 + CH_3-CH=CH_2 \xrightarrow{H_3PO_4}$ ________.

7.37 $CH_2 = CH_2 + CO + H_2 \xrightarrow{[Co(CO)_4]_2}$ ____(i)____ $\xrightarrow{N_2/Ni} CH_3CH_2CH_2OH$. This reaction is called the ________for industrial preparation of alcohols

7.38 $CHCl_3 + O_2 \xrightarrow{light}$ ________$+2HCl$

7.39 $CHCl_3 + 6Ag \longrightarrow$________$+6\ AgCl$

7.40 $C_6H_5SO_3Na + NaOH \xrightarrow{fuse} \longrightarrow$________$+Na_2SO_3$

7.41 $3CH_2=CH_2 + 2KMnO_4 + 4H_2O \longrightarrow$________$+2MnO_2 + 2KOH$.

7.42 $CH_3Br + NaOH \longrightarrow$____(i)____+____(ii)____.

7.43 The alcohols react with strong mineral acids to form ________ ions.

7.44 Treatment of sodium phenoxide with CO_2 followed by acidification produces 2-hydroxybenzoic acid This is called ________reaction

7.45 Hydrolysis of glyceride of higher fatty acids in the presence of an alkali yields glycerol and ________

7.46 On treatment with sodium metal in the presence of dry ether, methyliodide produces ____(i)____ This reaction is called____(ii)____.

(C) True or False Type

Classify the following statements as true (T) or false (F)·

7.47 In 3 -Methyl-1-hydroxy benzene, the methyl group is para position to the hydroxy group.

7.48 2-Methyl-2-propanol is an example of a secondary alcohol.

7.49 The conversion of bromomethane to methanol by the action of sodium hydroxide is a nucleophilic substitution reaction.

7.50 The reaction of RMgX (Grignard's reagent) with any aldehyde yields a primary alocohol

7.51 Glyceryl trinitrate is used in the making of dynamite.

7.52 Lower alcohols have higher viscosity than higher alcohols.

7.53 $LiAlH_4$ is a powerful oxidising agent.

7.54 Phenols and alcohols react with sodium metal to form the corresponding-ONa compounds.

7.55 Methyl ethanoate is prepared from ethanol and methanoic acid.

7.56 Action of alkaline potassium permanganate on ethene yields 1,2-ethanediol.

7.57 CN^- is an example of an electrophile

7.58 Haloarenes are more reactive than haloalkanes

7.59 In the presence of peroxides, addition of HBr to unsymmetrical olefins take place contrary to Markowikoff's rule. This is known as the Kharasch effect

7.60 On nitration, chlorobenzene forms 3-Nitro-1-chlorobenzene

7.61 Chloromethane is polar in nature.

7.62 Nucleophiles attack haloalkanes at the carbon atom to which the halogen atom is attached

7.63 Phenols undergo substitution readily in the benzene ring to form 3-substituted products

(D) Matching Type

Match the items given in List A with relevant answers given in List B by indicating the serial number of the item in List A against the matching item in List B.

7.64

LIST A *Compound*	LIST B *Used in the manufacture of/Used as*
(a) glycerol	(i) insecticide
(b) DDT	(ii) solvent in paint industry
(c) BHC	(iii) pesticide
(d) ethanol	(iv) glyptal
	(v) wood spirit

7.65

LIST A *Name of reaction*	LIST B *Example*
(a) Wurtz reaction	(i) $C_6H_5\overset{+}{N}\equiv N\bar{C}l \xrightarrow[HCl]{Cu_2Cl_2} C_6H_5Cl$
(b) Kolbe's reaction	(ii) $C_6H_5\bar{O}Na^+ \xrightarrow[4-7atm]{CO_2/400K}$ intermediate $\xrightarrow{H_3O^+} C_6H_4(OH)COOH$
(c) Reimer-Tiemann reaction	(iii) $2R-I+2Na \xrightarrow{\text{dry ether}} R-R+2NaI$
(d) Sandmeyers' reaction	(iv) $CH_3CH=CH_2 + HBr \xrightarrow{(C_6H_3COS)_3}$ Bromopropane

(v) $C_6H_5OH + CHCl_3 + NaOH \xrightarrow{340K}$

Intermediate $\xrightarrow{H_3O^+}$

2-Hydroxybenzaldehyde +

4-Hydroxybenzaldehyde

7.66

	LIST A *Compound*		LIST B *Commonly known as*
(a)	$COCl_2$	(i)	iodoform
(b)	CHI_3	(ii)	gammexane
(c)	$C_6H_6Cl_6$	(iii)	Grignard's reagent
(d)	RMgX	(iv)	phosgene
(e)	2-Acetoxybenzoic acid	(v)	cumene
		(vi)	salicylic acid
		(vii)	aspirin

II SHORT-ANSWER TYPE ITEMS

7.67 Why is it that benzene and iodine react to give iodobenzene only in the presence of HNO_3?

7.68 Though polar, alkyl halides are insoluble in water. Why?

7.69 Under what condition does the addition of hydrogen halides to alkenes take place contrary to Markownikoff's rule?

7.70 Ethyliodide has higher boiling point than ethylchloride. Why?

7.71 Why does phenol have lower dipole moment than methanol?

7.72 Why is it that alcohols are miscible with water but alkyl halides are not?

7.73 Why do phenols react with NaOH while alcohols do not?

7.74 State the rules of nomenclature of haloalkanes under the IUPAC system.

7.75 How are alcohols classified on the basis of number of OH groups present in them? Give suitable examples.

7.76 Write the structural formula and the IUPAC names of alcohols having the molecular formula C_4H_9OH

7.77 Explain 'peroxide effect' with an illustration

7.78 Why is a small amount of ethanol added while storing trichloromethane?

7.79 1-Bromopropane is soluble in organic solvents but is insoluble in water. Explain.

7.80 Explain why haloarenes are less reactive than haloalkanes.

7.81 How is dynamite prepared?

7.82 How is glycerol prepared?

III. LONG-ANSWER TYPE ITEMS

7.83 Taking propyl chloride as the example, describe what you understand by nucleophilic substitution reaction

7.84 Explain with equations the amphoteric character of ethanol

7.85 How is nitration of phenols carried out? What are the products? Give the appropriate equation How would you think the acidity of phenol be affected, if a nitrogroup is attached to the benzene ring at different positions?

7.86 Explain the capacity of alcohols and phenols to form hydrogen bonds.

7.87 Explain the reaction of ethanol with conc. sulphuric acid at 413 K and at temperatures higher than this

7.88 Explain with an example (a) the cleavage of carbon-oxygen bonds and (b) the cleavage of oxygen-hydrogen bonds in alcohols.

7.89 Explain the following with an example for each·
- (a) Kolbe's reaction
- (b) Reimer-Tiemann reaction

7.90 What are Grignard reagents? Explain how they are useful in preparing:
- (a) primary alcohols
- (b) secondary alcohols
- (c) tertiary alcohols

IV. NUMERICAL PROBLEMS

7.91 Make the following conversions:
- (a) 2-Methylprop-2-ene to 3-methylbutanol
- (b) Propyne to propan-1,2-diol
- (c) Propene to propanol
- (d) Benzene to phenylethanoate

7.92 An olefin A, C_4H_8 on ozonolysis in the presence of Zn dust gives two compounds B and C. B on reduction with $LiAlH_4$ is converted to D which gives a positive idoform test. Identify the compounds A, B,C, and D. Explain the reactions involved

7.93 (a) A small piece of freshly cut sodium is added to a non-acidic compound (A) with molecular formula C_3H_8O. A gas is liberated which forms an explosive mixture with air. Identify the compound A, and write the equation involved in the process above.

(b) A compound (B) of formula C_3H_8O is heated with aqueous sodium carbonate and iodine solution. As the reaction mixture is warmed, a yellow precipitate (C) is formed. Identify B, C and write the reaction involved in the process.

(c) A compound (D) containing C, H and Cl only, has a molecular mass of 119.5. When this is heated with ethanolic KOH and bezenamine a nauseating odour is obtained Identify (D) and write the reaction involved in the process. What is the IUPAC nomenclature of D?

UNIT 8

Organic Chemistry Based on Functional Group II

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer :

8.1 The IUPAC name of the compound,

$CH_3CH_2CH_2-O-CH_2CH_2CH_2CH_3$ is :

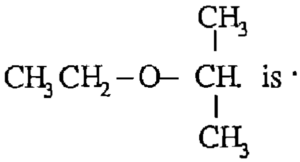
(a) Heptane oxide

(b) Butylpropyloxide

(c) 1-Butoxypropane

(d) 1-Propoxybutane

8.2 The IUPAC name of the compound,



$CH_3CH_2-O-\underset{\substack{|\\ CH_3}}{\overset{\substack{CH_3\\ |}}{CH}}$ is :

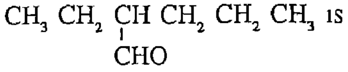
(a) Ethyl propyloxide
(b) Ethoxypropane
(c) 2-Ethoxypropane
(d) 2-Propoxyethane.

8.3 The IUPAC name of the compound,

$CH_3CH_2CH_2CHO$ is

(a) Butyl aldehyde
(b) Propyl methanal
(c) Butanal
(d) Methyl Propanal.

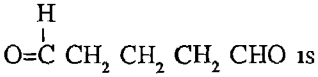
8.4 The IUPAC name of the compound,



$CH_3\,CH_2\,\underset{CHO}{\underset{|}{CH}}\,CH_2\,CH_2\,CH_3$ is

(a) Butylethylmethanal
(b) 3-Formylhexane
(b) 3-Oxahexane
(c) 2-Ethylpentanal

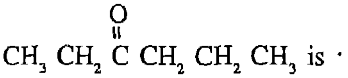
8.5 The IUPAC name of the compound,



$O{=}\overset{\overset{H}{|}}{C}\,CH_2\,CH_2\,CH_2\,CHO$ is

(a) 4-Formylbutanal
(b) Propylanedimethanol
(c) 1,3-Diformylpropane
(d) Pentane-1,5-dial

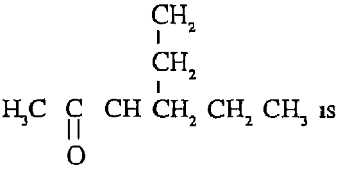
8 6 The IUPAC name of the compound,



$CH_3\,CH_2\,\overset{\overset{O}{\|}}{C}\,CH_2\,CH_2\,CH_3$ is

(a) Propylethylketone
(b) Ethylpropylketone
(c) Hexan-3-one
(d) 3-Oxohexane.

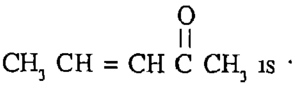
8.7 The IUPAC name of the compound,



$H_3C\,\underset{\underset{O}{\|}}{C}\,\,CH\,\overset{\overset{\overset{CH_2}{|}}{CH_2}}{\overset{|}{CH_2}}\,CH_2\,CH_3$ is

(a) 3-Acetylhexane
(b) Ethylpropylpropan-2-one
(c) Methyl-3-hexyl ketone
(d) 3-Ethylhexan-2-one.

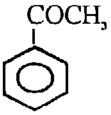
8 8 The IUPAC name of the compound



$CH_3\,CH = CH\,\overset{\overset{O}{\|}}{C}\,CH_3$ is

(a) Methyl propane ketone
(b) 1-Acetyl propene
(c) 4-oxopentene-2
(d) Pent-3-en-2-one

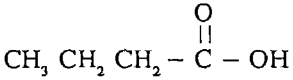
8.9 The IUPAC name of the compound,



is :

(a) Acetophenone
(b) Methyl hexyl ketone
(c) Phenylethanone
(d) Benzylacetone.

8.10 The IUPAC name of the compound,



$CH_3CH_2CH_2-\overset{O}{\overset{\|}{C}}-OH$ is .

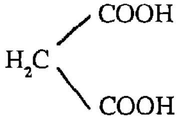
(a) Butanoic acid
(b) Butyric acid
(c) Propylmethanoic acid
(d) 1-oxy-1-butanol.

8.11 The IUPAC name of the compound,

$HOOC\,CH_2\,CH_2\,CH_2\,COOH$ is ·

(a) 4-Carboxylbutanoic acid
(b) 4-Carboxylbutyric acid
(c) 1, 3-Propane dicarboxylic acid
(d) 1, 5-Pentanedioic acid

8.12 The IUPAC name of the compound,

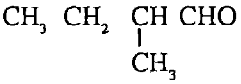


is ·

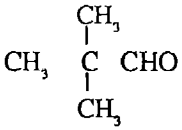
(a) Methandioic acid
(b) Malonic acid
(c) 2-Carboxyl ethanoic acid
(d) Propane-1,3-dioic acid

8.13 Which of the following aldehydes undergoes Cannizarro's reaction?

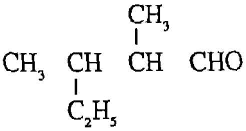
(a) $CH_3\,CH_2\,CHO$

(b) 

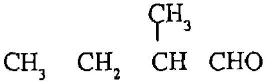
$CH_3\,CH_2\,\underset{CH_3}{\underset{|}{CH}}\,CHO$

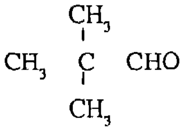
(c) 

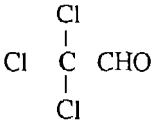
$CH_3\,\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}\,CHO$

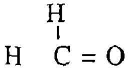
(d) 
$\mathrm{CH_3\ \underset{C_2H_5}{\underset{|}{CH}}\ \overset{CH_3}{\overset{|}{CH}}\ CHO}$

8 14 Which of the following aldehydes undergoes addol condensation reaction?

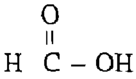
(a) 
$\mathrm{CH_3\ \ CH_2\ \ \overset{CH_3}{\overset{|}{CH}}\ CHO}$

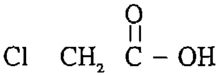
(b) 
$\mathrm{CH_3\ \ \underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}\ \ CHO}$

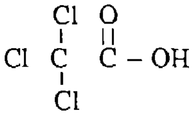
(c) 
$\mathrm{Cl\ \ \underset{Cl}{\underset{|}{\overset{Cl}{\overset{|}{C}}}}\ \ CHO}$

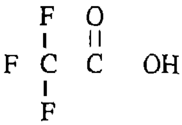
(d) 
$\mathrm{H\ \ \overset{H}{\overset{|}{C}} = O}$

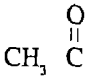
8 15 Of the following which should be the strongest organic acid?

(a) 
$\mathrm{H\ \ \overset{O}{\overset{||}{C}} - OH}$

(b) 
$\mathrm{Cl\ \ CH_2\ \overset{O}{\overset{||}{C}} - OH}$

(c) 
$\mathrm{Cl\ \underset{Cl}{\underset{|}{\overset{Cl}{\overset{|}{C}}}}\ \ \overset{O}{\overset{||}{C}} - OH}$

(d) 
$\mathrm{F\ \underset{F}{\underset{|}{\overset{F}{\overset{|}{C}}}}\ \ \overset{O}{\overset{||}{C}}\ \ OH}$

8.16 Treatment of  $\mathrm{CH_3\ \overset{O}{\overset{||}{C}}\ OH}$ with PCl_5 gives :

(a) Ethanoyl chloride
(b) 1-Chloroacetone
(c) 1,3-Dichloroacetone
(d) 2,2-Dichloropropane.

8 17 Ethanoyl Chloride when subjected to Rosenmund reduction produces :
(a) Benzaldehyde
(b) Propanone
(c) Ethanal
(d) Ethanoic anhydride

8 18 Reduction of Ethanoic acid with $LiAlH_4$ produces .
(a) Ethanol
(b) Ethanal
(c) Ethanoic anhydride
(d) Lithium ethanoate.

8.19 Benzoic acid on treatment with conc. NHO_3 and conc. H_2SO_4 produces
(a) 4-Nitrobenzoic acid
(b) 2-Nitrobenzoic acid
(c) 3-Nitrobenzoic acid
(d) 2,6-Dinitrobenzoic acid

8 20 The reaction

$C_2H_5ONa + CH_3Br \longrightarrow C_2H_5OCH_3 + NaBr$ is known as ·
(a) Hofmann Bromamide degradation
(b) Kolbe's reaction
(c) Cannizaro's reaction
(d) Williamson's synthesis

8 21 When Ethoxyethane reacts with HI it gives :
(a) Butanol
(b) Diethyl oxonium chloride
(c) Iodoethane
(d) Iodobutane.

8 22 When Methanal reacts with CH_3 MgBr followed by hydrolysis, the product formed is .
(a) Ethanol
(b) Acetone
(c) Methoxy methane
(d) Ethyl bromide

8 23 When propanone is subjected to Wolff Kishner reduction, it gives ·
(a) 2-Propanol
(b) Propene
(c) Propane
(d) 1-Propanol

(B) Completion Type

Complete the following :

8.24 The IUPAC name of

$CH_3OCH_2 CH_2OCH_3$ is ________________.

8.25 Vapours of ethanol when passed over a heated metallic catalyst such as copper yields __________.

8.26 Most reactions of aldehydes and ketones are similar due to the presence of common __________ group

8.27 The boiling point of an aldehyde is __________ than that of the corresponding alcohol or carboxylic acid

8.28 In Cannizzaro reaction the final product is a mixture of an______(i)_____, and a_____(ii)______

8.29 __________ of alkenes followed by reduction with zinc and water yields aldehydes or ketones or a mixture of both

8.30 Aromatic aldehydes containing hydroxy groups are prepared by __________.

8.31 Acyl chloride reacts with water to give________(i)__________; with alcohols and phenols to give_____(ii)____; with ammonia and amines to give______(iii)_____; with carboxylates to give______(iv)______and with aromatic compounds in the presence of aluminium chlorides as catalyst to give_____(v)_____.

8.32 (a) $CH_3CHO + CH_3CHO \xrightarrow{OH^-}$ _____(i)_____ $\xrightarrow{Heat}$ _____(ii)_____ $+ H_2O$
the IUPAC names of compounds in (i) and (ii) above are __________, and __________, respectively.

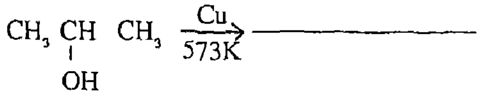
(b) $(RCO)_2O \xrightarrow{R'OH}$ __________ $+$ RCOOH

(c) $RCONH_2 + 4NaOH + Br_2 \longrightarrow$ ______ $+ 2NaBr + Na_2CO_3 + 2\,H_2O$

(d) $RCONH_2 \xrightarrow[Heat]{P_2O_5}$ ________ $+ H_2O$

(e) __________ $+ NaOH \xrightarrow{heat} CH_4 + Na_2CO_3$

(f) $C_6H_5(COOH) \xrightarrow{sulphonation}$ ___(i)___ . The compound formed is called ____(ii)____

(g)

$CH_3\underset{\large OH}{\underset{|}{C}H}\,CH_3 \xrightarrow[573K]{Cu}$ ________________

(C) True or False Type

Classify the following statements as true (T) or false (F) :

8.33 The IUPAC name of $CH_3OC_3H_7$ is methoxypropane.

8.34 Ethers possess a net dipole moment even though they are symmetrical.

8.35 Similar to alcohols, ethers also show molecular association by intermolecular hydrogen bonding

8 36 Ethers have bent structures with a C–O–C bond angle of 110°.

8 37 Oxidation of alcohols to aldehydes is carried out under controlled conditions because aldehydes undergo further oxidation to carboxylic acid very easily.

8.38 Aldehydes and ketones whether aliphatic or aromatic can be prepared by similar methods

8 39 A ketone is easily oxidised to a carboxylic acid when heated with common oxidising agents such as $KMnO_4$ The carboxylic acid so formed contains the same number of carbon atoms as the original ketone.

8.40 Propanone gives silver mirror test with Tollen's reagent.

8 41 Methanal is a liquid at room temperature

8.42 Grignard reagents add to an aldehyde or a ketone to give an alcohol.

8.43 Ethers can be cleaved by strong acids at high temperature.

8 44 $RCONH_2 \xrightarrow[\text{Heat}]{P_2O_5} R-C\equiv N + H_2O$

8.45 Chloroacetic acid is a stronger acid than acetic acid.

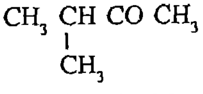
8 46 Reduction of propionic acid with $LiAlH_4$ will produce propanol.

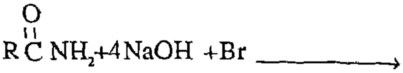
8 47 Amides are acidic in character.

8.48 Propanamide when subjected to Hofmann Bromamide reaction gives propylamine.

(D) Matching Type

8 49 Match the items given in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B.

	LIST A		LIST B
	IUPAC name		*Formula*
(a)	1,2-Dimethoxyethane	(i)	CH_3COOH
(b)	Ethylethanoate	(ii)	 $CH_3\underset{\displaystyle CH_3}{\underset{\mid}{C}H}\,CO\,CH_3$
(c)	Ethanoic acid	(iii)	$CH_3\ CO-O-CO-CH_3$
(d)	Ethanoic anhydride	(iv)	$C_6H_5\ (CH_2\ CH_2\ CH_3)$
(e)	2-Butenal	(v)	$CH_3O\ CH_2\ CH_2\ OCH_3$
(f)	3-Methyl-2-butanone	(vi)	$CH_3CH_2\ (OH)\ CH_2\ CHO$
		(vii)	$CH_3\ CH=CHCHO$
		(viii)	$CH_3COOC_2H_5$

8.50	LIST A *Name of reaction*		LIST B *Corresponding equation*
(a)	Cannizzaro reaction	(i)	 $R\overset{O}{\overset{\parallel}{C}}NH_2 + 4NaOH + Br \longrightarrow RNH_2 + 2NaBr + Na_2CO_3 + 2H_2O$
(b)	Hofmann Bromamide reaction	(ii)	$H_2 + RCOCl \xrightarrow{Pd/BaSO_4} RCHO + HCl$
(c)	Clemmensen reduction	(iii)	$C_2H_5MgBr + CO_2 \longrightarrow C_2H_5CO_2MgBr \xrightarrow{H_2O} C_2H_5COOH + MgOHBr.$
(d)	Wolff-Kishner reduction	(iv)	$RCHO \xrightarrow{NH_2NH_2} RCH{=}NNH_2 \xrightarrow[glycol]{KOH} RCH_3 + N_2$
(e)	Rosenmund reaction	(v)	$RCHO + 4\,(H) \xrightarrow{Zn/HCl} RCH_3 + H_2O$
		(vi)	$2HCHO \xrightarrow{NaOH} CH_3OH + HCOO^-Na^+$

II. SHORT-ANSWER TYPE ITEMS

8.51 What is Williamson's synthesis? Give an example.

8.52 What are ethers? List two important uses of ethoxyethane

8.53 Why do ethers possess a net dipole moment even if they are symmetrical?

8.54 Aldehydes and ketones have lower boiling points than the corresponding alcohols Why?

8.55 Write any two methods for the preparation of aromatic ketones Write the corresponding equations.

8.56 Write the mechanism of the addition of $NaHSO_3$ to a $> C = O$ group

8.57 What is Cannizzaro reaction? What type of aldehydes give this reaction? Can this reaction be used to distinguish between methanal and ethanal?

8.58 Give two tests to distinguish between aldehydes and ketones

8.59 Why is chloroacetic acid a stronger acid than acetic acid?

8.60 Why do carboxylic acids have higher boiling points than alcohols of comparable molecular mass?

8.61 Why do the acyl chlorides have lower boiling points than the corresponding carboxylic acids in spite of their greater molecular mass?

8.62 Why are acid anhydrides used in acylation in preference to acyl chlorides?

8.63 What are the methods used for conversion of alcohols to esters ? Give equations for each of these methods.

8.64 What is the Hofmann Bromamide reaction? Explain with appropriate equation.

III LONG-ANSWER TYPE ITEMS

8.65 What are the two general methods for preparation of ethers? Explain with examples

8 66 Explain with example the IUPAC nomenclature for aldehydes and ketones.

8 67 Discuss the addition reactions that aldehydes and ketones undergo. Give equations for each reaction.

8 68 Write the equations of the reactions of ethanal with:
- (i) dilute NaOH
- (ii) Fehling's solution
- (iii) phenylhydrazine
- (iv) hydroxylamine.

8 69 Write the equations for the following reactions:
- (a) Cleavage of ethers with hydrogen halides.
- (b) Reduction of ethanoylchloride with hydrogen in the presence of palladium on $BaSO_4$ catalyst.
- (c) Reaction of ethanol with ethanoic anhydride.
- (d) Reduction of acetone with $LiAlH_4$.

8.70 Discuss how substituents on the alphatic chain of a carboxylic acid affect its acidity.

8 71 Comment on the following statement.

'Carboxyl group in benzoic acid is an electron withdrawing group and therefore it is m-directing'. Support your view with proper examples.

8 72 'Acyl chlorides are vigorous acylating agents'. Support this statement with appropriate examples

IV. PROBLEM TYPE ITEMS

8 73 Affect the following conversion:
- (a) Benzene to 3-Nitrobenzoic acid
- (b) Benzene to Phenylethene
- (c) Benzene to Methylbenzoate
- (d) Benzene to Benzamide
- (e) 2-Methyl -1-bromopropane to 3-Methylbutanal
- (f) Ethanal to butan -1,3-diol.

8.74 An aliphatic compound (A) with a molecular formula of C_3H_6O reacts with phenylhydrazine to give a compound (B) Reaction of (A) with iodine in alkaline medium on warming, gives a yellow precipitate (C). Identify compounds (A), (B), and (C).

8.75 2 moles of an organic compund (A) on treatment with a strong base gives 2 compounds (B) and (C) Compound (B) on dehydrogenation with copper gives (A), while acidification of (C) yields carboxylic acid (D), having a molecular formula of CH_2O_2 Identify the compounds (A), (B), (C) and D.

UNIT 9

Organic Chemistry Based on Functional Group III

(Cyanides, Isocyanides, Nitro Compounds and Amines)

I. OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer :

9.1 The IUPAC name of $CH_2 = CH\ CN$ is :
- (a) vinylcyanide
- (b) acrylonitrile
- (c) 2-propencyanide
- (d) 2-propenenitrile

9.2 The IUPAC name of $CH_3CH_2NH_2$ is :
- (a) ethanamine
- (b) anilin
- (c) ethylamine
- (d) aminoethane.

9.3 The IUPAC name of C_6H_5CN is .
- (a) phenylcyanide
- (b) benzonitrile
- (c) benzenecyanide
- (d) phenonitrile.

9.4 The compound that has the smell of bitter almond is :
- (a) nitromethane
- (b) nitrobenzene
- (c) 2, 4, 6-Trinitromethylbenzene
- (d) 2-Nitropropane.

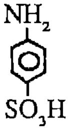
9.5 Nitrocompounds on reduction with lithium aluminium hydride gives :
- (a) tertiary amine

- (b) secondary amine
- (c) primary amine
- (d) None of the above (a,b,c)

9 6 Aromatic amines·
- (a) are coloured compounds when pure and freshly prepared
- (b) are non-toxic
- (c) are very easily oxidised by air
- (d) are insoluble in water as well as in organic solvents, viz. benzene, ether and alcohol.

9.7 Both alky and aryl nitriles can easily be obtained
- (a) by dehydration of acid amides
- (b) by substitution reaction of corresponding alkyl halides using sodium or potassium cyanide
- (c) from diazonium salts
- (d) by all the 3 methods above (a,b,c)

9.8 The IUPAC name of :



is ·

- (a) sulphanilic acid
- (b) 4-aminobenzenesulphonic acid
- (c) p-aminobenzenesulphonic acid
- (d) 4-anilinosulphonic acid

9 9 The functional group of alkanenitriles is
- (a) $-CN$
- (b) $-NO_2$
- (c) $-NH_2$
- (d) $-NC$

9 10 The IUPAC name of $CH_3CH_2NH_2$ is:
- (a) vinylcyanide
- (b) acrylonitrite
- (c) ethylamine
- (d) propencyanide

9.11 Cyanides are generally compounds:
- (a) with disagreeable odour
- (b) with high dipole moment
- (c) whose solubility in water increases with increasing carbon content
- (d) with low boiling points.

9.12 Which will be the major product when an alkyl halide reacts with potassiumcyanide?
- (a) nitriles
- (b) isocyanides

(c) nitro compounds
(d) amines.

9 13 A nitro compound on treatment with hydrogen in presence of Ni yields :
(a) a tertiary amine
(b) a secondary amine
(c) a primary amine
(d) none of the above (a,b,c)

9 14 Benzenamine reacts with excess bromine to produce :
(a) 2, Bromobenzenamine
(b) 2,3-dibromobenzenamine
(c) 2,4-dibromobenzenamine
(d) 2,4,6-tribromobenzenamine.

9 15 Coupling of the diazonium salt of 4-aminobenzenesulphonic acid with N, N-dimethylbenzenamine produces the indicator .
(a) phenolphthalein
(b) methyl red
(c) methyl orange
(d) litmus

(B) Completion Type

Complete the following:

9.16 Substitution of two of the three hydrogen atoms in ammonia by alkyl/aryl group results in a __________ amine.

9 17 Nitriles can be considered as derivatives of __________ , obtained by replacing the hydrogen by an alkyl/aryl group.

9.18 Silver cyanide on reaction with alkyl halide gives __________ as the minor product

9 19 Nitriles generally have____(i)____odour, whereas the corresponding isonitriles have____(ii)____odour.

9.20 Functional groups such as –CN and –NC which can bond through two different atoms are known as __________groups.

9.21 Conversion of an alkyl halide to a nitrile results in the __________ of one C atom of the molecule.

9.22 Alkylamines are __________ bases than ammonia.

9.23 Sulpha drugs such as the sulphathiazole and sulphadiazine are prepared from __________ and its derivatives.

9.24 Amines are prepared by two general methods: by the action of ammonia or amines on ____(i)____ and by ____(ii)____ of nitro compounds, nitriles and amides.

9 25 Nitration of benzene is an example of an aromatic __________ substitution reaction

9 26 (a) $C_6H_5\,CONH_2 \xrightarrow{P_2O_5}$ ______________.

(b) $RNC + 2H_2 \xrightarrow{Pt\,or\,Ni}$ ________ + NaI

(c) $RI + NaNO_2 \longrightarrow$ ____________ + NaI.

(d) $(CH_3)_2NH + HCl \longrightarrow$ ____(i)____

This compound is a ____(ii)____ salt

(e) $AgCl +$ ____________ $\longrightarrow [Ag(CH_3NH_2)_2]^+ Cl^-$

(f) $Ar\overset{+}{N}_2X^- + CN^- \xrightarrow{CuCN}$ ________ $+ N_2 + X^-$

9.27 (a) The $C \equiv N$ in the nitriles can be completely reduced by hydrogen in the presence of catalysts to give __________ .

(b) Alkyl halides, especially iodides react with sodium nitrite to give ____(i)____ , via ____(ii)____ (ii) reaction.

(c) Nitro compounds can be readily reduced to ________ amines by a variety of reducing agents

(C) True or False Type

Classify the following statements as true (T) or false (F) :

9.28 Both akyl and aryl nitriles can be prepared from the corresponding diazonium salts.

9.29 Salts of amines are ionic compounds

9.30 Amines dissolve in acids to form quaternary salts.

9.31 Primary, secondary and tertiary amines all have a lone pair of electrons present on the nitrogen atom.

9.32 TNT and TNB are important commercial chemical explosives

9.33 Both aliphatic and aromatic primary amines undergo carbyl amine test

9.34 Nitration of benzene with a mixture of concentrated nitric and sulphuric acid, to give nitrobenzene is an example of an aromatic nucleophilic substitution reaction

9.35 All amines, whether primary, secondary or tertiary can form intermolecular hydrogen bonds.

9.36 Whether an amine is primary, secondary or tertiary is best shown by the Hinsberg test.

9.37 Tertiary amines react readily with acid chlorides to form substituted amides.

(D) Matching Type

Match the items given in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B.

9.38

LIST A *Compound*	LIST B *IUPAC name*
(a) CH_3CN	(i) ethanamine
(b) $CH_3CH_2NH_2$	(ii) benzenamine

(c) $C_6H_5NH_2$	(iii) benzonitrile
	(iv) Isocyanomethane
(d) C_6H_5CN	(v) isocyanomethane
(e) $C_2H_5NO_2$	(v) aminomethane
	(vi) ethanenitrile
	(vii) Aminobenzene
	(viii) nitroethane

9.39

LIST A *Functional group*	LIST B *Known as*
(a) $-CN$	(i) tertiary amine
(b) $-NO_2$	(ii) nitro
(c) $-\overset{\vert}{\underset{\vert}{N}}-$	(iii) primary amine
(d) $-\overset{\vert}{N}H$	(iv) isocyanide
(e) $-NH_2$	(v) nitrile
	(vi) secondary amine

9.40

LIST A *Reaction*	LIST B *Reaction type*
(a) $RNO_2+6(H) \longrightarrow RNH_2 + 2H_2O$	(i) nitration
(b) $C_6H_6+HNO_3 \xrightarrow{H_2SO_4} C_6H_5NO_2 + H_2O$	(ii) acylation
(c) $RCN \xrightarrow[H_3O^+]{HOH} RCOOH + NH_3$	(iii) reduction
(d) $C_6H_5NH_2+CH_3COCl \longrightarrow C_6H_5NHCOCH_3 + HCl$	(iv) hydrolysis
	(v) oxidation

II. SHORT-ANSWER TYPE ITEMS

9.41 Give equations for the following reactions:
- (a) Reduction of the carbon-nitrogen triple bond in nitriles.
- (b) Reduction of nitriles with $LiAlH_4$.
- (c) Vapour phase reduction of nitrobenzene with hydrogen using nickel or platinum catalyst

9.42 Why is it that alkylamines are stronger bases than arylamines?

9.43 Why does silver chloride dissolve in methylamine solution ?

9.44 Why do amines have lower boiling points than those of corresponding alcohols or carboxylic acids?

9.45 What is 4-aminobenzenesulphonic acid? How does it find use in the drug industry?

9.46 Name two nitro compounds used as explosives.

9.47 Give the appropriate equation for each of the following:
- (a) Electrophilic substitution of aromatic rings.
- (b) The formation of primary amines using the Hofmann bromamide degradation.
- (c) Acylation using acid anhydrides.
- (d) The formation of amines via nucleophilic substitution reaction of alkyl halides.

9.48 What are Hinsberg test and the carbylamine test?

III. LONG-ANSWER TYPE ITEMS

9.49 Explain the reaction mechanism of formation of alkylnitriles from alkyl halides.

9.50 Explain the term 'aromatic electrophilic substitution reaction' using nitration of benzene as the example.

9.51 Explain the polar nature and the hydrogen bond formation of amines.

9.52 How can one distinguish between primary, secondary and tertiary amines?

9.53 What are the two general methods for the preparation of amines? Give appropriate equations.

9.54 Explain the order of basicity in following compounds

CH_3NH_2 NH_3 $C_6H_5NH_2$

9.55 How do compounds of the types RNC and RCN undergo hydrolysis reactions?

9.56 What are the chief methods for the preparation of nitro compounds?

IV. PROBLEM TYPE ITEMS

9.57 Make the following conversions:
- (a) 4-Bromomethylbenzene to methylbenzene
- (b) Methylbenzene to benzonitrile
- (c) Bromocyclohexane to cyclohexamine

9.58 An aliphatic compound (A) with moleculer formula C_2H_3Cl on treatment with AgCN gives two isomeric compounds of unequal amounts with the molecular formula C_3H_3N. The minor of these two products on complete reduction with hydrogen in the presence of Ni gives a compound (B) with the molecular formula C_3H_9N Identify the compounds (A), (B) and write the appropriate equations, wherever possible.

9.59 Benzene reacts with a mixture of conc. H_2SO_4 and conc. HNO_3 forms a product (A) which on reduction , in presence of H_2/CuO at 680K forms (B). (B) on treating with sulphuric acid and heating gives 4-Aminobenzenesulphonic acid The indicator (C) is obtained by coupling the diazonium salt of 4-Aminobenzenesulphonic acid with N, N-dimethyl phenylamine. Give the names of compounds (A), (B), and (C) and write the corresponding reactions, wherever possible

9.60 Iodomethane reacts with potassium cyanide to form a major product 'A'. Compound 'A' on reduction in presence of $LiAlH_4$ forms a higher amine 'B'. Compound 'B' on treating with $CuCl_2$ forms a blue colour complex 'C'. Identify the compounds 'A', 'B', and 'C'.

UNIT 10

Chemistry of Main Group Elements

(s- and p-block Elements)

I OBJECTIVE TYPE ITEMS

(A) **Multiple Choice**

Write the correct answer :

10.1 Down the groups the metallic character of the s- and p-block elements :
- (a) decreases
- (b) increases
- (c) remains relatively constant
- (d) does not vary in a regular manner

10.2 Alkali metals reacts with acetylene and liberate :
- (a) carbon monoxide
- (b) carbon dioxide
- (c) water vapour
- (d) hydrogen

10.3 Lithium shows chemical similarities with :
- (a) beryllium
- (b) magnesium
- (c) aluminium
- (d) calcium

10.4 Alkali metal hydroxides are :
- (a) basic
- (b) acidic
- (c) neutral
- (d) amphoteric

10.5 The outer electronic configuration of the alkaline earth metals is :
- (a) ns^1
- (b) ns^2

(c) $ns^2 np^1$
(d) ns^2np^2.

10.6 Of the following sulphates, the most soluble in water is :
(a) $MgSO_4$
(b) $CaSO_4$
(c) $SrSO_4$
(d) $BaSO_4$

10.7 Which of the following does not react readily even with boiling water?
(a) lithium
(b) sodium
(c) beryllium
(d) calcium

10.8 The structure of beryllium chloride is :
(a) a chloro bridged dimer in the solid state
(b) a chain structure at all temperatures
(c) a linear triatomic monomer at high temperature
(d) a bent structure in the vapour phase.

10.9 An element X has atomic number 5. The number of valence electrons are .
(a) 1
(b) 2
(c) 3
(d) 4

10.10 The boranes contain :
(a) boron, hydrogen and oxygen
(b) boron and oxygen
(c) boron and hydrogen
(d) boron, hydrogen and carbon.

10.11 Boron trihalides are :
(a) ionic species
(b) compounds with sp^2 hybridisation of B
(c) strong Lewis bases
(d) non-planer.

10.12 Which of the following is acidic?
(a) SiO_2
(b) Al_2O_3
(c) PbO_2
(d) SnO_2

10.13 Which of the following forms the maximum number of hydrides?
(a) carbon
(b) boron

(c) silicon
(d) nitrogen.

10 14 Synthetic polymers containing repeated R_2SiO units are.
(a) silicates
(b) silicones
(c) silica
(d) silanes.

10 15 All group 15 hydrides of the type MH_3 are .
(a) gaseous hydrides
(b) basic in character
(c) associated in the liquid state via hydrogen bonds
(d) soluble in water.

10.16 Carbon does not form a stable dihalide, whereas lead, also a group 14 element, does, because·
(a) carbon is a non-metal and lead is a metal
(b) carbon cannot expand its octet
(c) lead shows inert pair effect
(d) lead atom is larger than a carbon atom.

10.17 An important characteristic of the group 14 elements is
(a) due to high ionization energies, simple M^{4+} ions of the group are not known
(b) none of the elements of the group has any tendency to form negative ions by gaining electrons
(c) a steady decrease in the metallic character with increasing atomic number
(d) the increasing thermal stability of the tetravalent state with respect to the divalent state.

10 18 Carbon monoxide is isoelectronic with:
(a) N_2
(b) O_2
(c) F_2
(d) H_2O

10.19 Of the following halides the most ionic is
(a) NCl_3
(b) PBr_3
(c) AsF_3
(d) BiF_3

10.20 Interhalogen compounds are·
(a) mostly the iodides
(b) strong oxidising agents
(c) essentially ionic
(d) generally less reactive than halogens

10.21 The structure of XeF_2 is .
(a) pentagonal
(b) trigonal bipyramidal
(c) square pyramid
(d) linear.

10.22 Of the following elements, the one that does not exhibit allotropy is ·
(a) oxygen
(b) nitrogen
(c) sulphur
(d) phosphorus.

10.23 The oxidation state of oxygen atom in potassium superoxide KO_2 is
(a) $-\frac{1}{2}$
(b) -1
(c) $+1$
(d) $+\frac{1}{2}$

10.24 An important property of hydrogen is :
(a) its high first ionisation energy
(b) its ability to form ionic compounds with all elements
(c) the nonpolar character of its bonds to other elements
(d) its ability to form H^- ions only with elements with high ionization energies.

(B) Completion Type

Complete the following.

10.25 The only important oxidation state of alkali metals is ______________.

10.26 The blue colour of the alkali metal-ammonia solution is due to the presence of ______________ .

10.27 The chemical similarities of beryllium and aluminium is referred to as __________.

10.28 The only group 1 element to form a nitride is________.

10.29 Lithium nitrate decomposes on heating to give___(i)___, whereas sodium nitrate decomposes to give____(ii)____ .

10.30 The alkaline earth metal hydroxides are____(i)____ basic and____(ii)____stable than the alkali metal hydroxides

10.31 Boron in group 13 shows similarity with __________in group 14

10.32 The number of B-H bonds (terminal) in diborone is____(i)____, and the total number of valence electrons is____(ii)____

10.33 Zero dipole moment of CO_2 suggests that it is a ______________molecule

10.34 The maximum number of covalent bonds formed by nitrogen is ______________.

10.35 The most common and important group 16 hydride is ______________

10.36 The structure of sulphur hexafluoride is ______________.

10.37 The only halogen that does not exhibit formal positive oxidation state is __________.

10.38 (a) $XeF_2 + PF_5 \longrightarrow$ ______________.

(b) $NH_4NO_3 \xrightarrow{heat}$ ____(i)____ + ____(ii)____.

(c) $2NH_3 + NaOCl \longrightarrow$ ____(i)____ + ____(ii)____ + H_2O

(d) $6Li + N_2 \longrightarrow$ __________.

(c) $SiCi_4 + 4H_2O \longrightarrow$ __________ + 4HCl.

(C) True or False Type

Classify the following statements as true (T) or false (F) :

10.39 The atomic radius of sodium is less than that of chlorine

10.40 Caesium is more electropositive than sodium

10.41 Alkali metals combine with non-metals to form ionic compounds

10.42 Beryllium chloride and magnesium chloride are structurally similar.

10.43 BF_3 has strong Lewis base character

10.44 Boron forms predominantly covalent compounds

10.45 Thallium trichloride is more stable than thallium monochloride.

10.46 The stability of group 15 hydrides follows the order:
$NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

10.47 Oxides of nitrogen and phosphorus are structurally identical.

10.48 The pentahalo compounds of group 15 elements are fewer in number compared to trihalo compounds

10.49 Like dioxygen (O_2), S_2 is paramagnetic

10.50 Elemental sulphur is used in xerography, in photoelectric cells and as a rectifier in semiconductor devices.

10.51 Group 16 elements do not form the trioxides of the type MO_3.

10.52 Slaked lime reacts with chlorine to give a compound with the composition $Ca(OCl)_2\ CaCl_2\ Ca(OH)_2 . 2H_2O$.

10.53 AMP, ADP and ATP are three important phosphate esters.

10.54 All hydrides of group 15 elements are associated via hydrogen bond in the liquid state.

(D) Matching Type

Match the items given in List A with relevant answers given in the List B by indicating the serial number of the item of List A against that of List B.

10.55

LIST A *Element/Compound*	LIST B *Corresponding property*
(a) carbon	(i) catenation
(b) diborane	(ii) basic oxide
(c) $Ni(CO)_4$	(iii) multicentre bonds
(d) arsenic	(iv) organometallic compound
	(v) metalloid

10.56

LIST A *Compound/Element*	LIST B *Structure/Characteristic*
(a) beryllium chloride (in solid state)	(i) linear
(b) black phosphorous	(ii) pyramidal
(c) PX_3 (X=halogen)	(iii) chain
(d) SF_4	(iv) square planar
	(v) layer
	(vi) trigonal bipyramidal

II. SHORT-ANSWER TYPE ITEMS

10.57 Why are alkali metals always univalent?

10.58 Why does beryllium chloride react with water to give an acidic solution?

10.59 Why is F_2O referred to as a fluoride but Cl_2O as an oxide?

10.60 Why does Li differ from the other members of its group?

10.61 Why are alkali metals strong reducing agents?

10.62 Heat of hydration for Na^+ (size 102 pm)= -397 kJ mol^{-1}, whereas that of Ca^{2+} (size 100 pm)= -1650 kJ mol^{-1}. Explain the difference

10.63 In terms of atomic size, ionization energy, and charge, explain why are ionic compounds containing B^{3+} not formed?

10.64 What is 'inert pair effect'? Give examples

10.65 In what ways does C differ from other elements of group 14 ?

10.66 What are (i) silicates, (ii) silicones?

10.67 Does hydrogen ion exist in the free state? Explain.

10.68 How are the different oxides of group 15 prepared?

10.69 What is meant by "allotropy of elements"? What are the allotropes of sulphur?

10.70 Name the most electronegative element To which group of the periodic table does it belong? Write the formulae of its compounds with oxygen

10.71 What are the clathrate compounds of noble gases? What is the nature of forces holding the noble gases in them?

10.72 Give reasons for the following:
(a) A metal fluoride is more ionic than its chloride
(b) Xenon forms compounds with only oxygen and fluorine
(c) In interhalogen compounds of the type AB_5 and AB_7, B is invariably fluorine
(d) CO_2 is a gas but SiO_2 a solid

III LONG-ANSWER TYPE ITEMS

10.73 Explain how the first element of a group differs in many ways from the heavier members of the group.

10.74 Give examples to show that alkali metals are strong reducing agents.

10.75 Why do alkali metals impart colour to the bunsen flame?

10.76 How does the reactivity of alkaline earth metals towards oxygen and towards water, vary down the group?

10.77 Beryllium and aluminium resemble each other in some of their properties How is this illustrated in
(a) the reaction of the two metals with acids?
(b) the nature of their oxides?
(c) the structure of their chlorides?

10.78 How is the bonding in diborane described in terms of multi centre bonds?

10.79 "Oxides of the group 14 elements having the composition MO_2 differ in their structure and properties." Give examples to support this statement and explain the differences

10.80 What are synthetic silicone polymers?

10.81 How does the structure of ammonia explain its basic properties?

10.82 Electron affinity value generally decreases down a group But in case of halogens, the electron affinity values (in kJ mol^{-1}) is F: 322, Cl 349, Br: 324, I 295. Explain the discrepancy in case of F.

IV. PROBLEM TYPE ITEMS

10.83 An element (A) belongs to group 15 of the periodic table It exists widely in nature. It reacts with hydrogen to form a hydride which is basic in nature. It also reacts with oxygen to give a number of oxides which are acidic. Based on this information answer the following.

- (a) What is the general outer electronic configuration of the group to which (A) belongs?
- (b) What is the formula of the hydride formed?
- (c) Is (A) a metal or a non-metal?
- (d) Can you identify (A)?

10 84 X_2 is greenish yellow gas with an offensive odour used in water purification. It partially dissolves in water to give a solution which turns blue litmus red. When X_2 is bubbled through sodium bromide solution bromine is obtained.

- (a) Can you identify X_2 ?
- (b) To what group of the periodic table does X belong?
- (c) What is the general outer electronic configuration for this group?
- (d) What are the products obtained when X_2 reacts with water? Write the corresponding equation.
- (e) Give an equation to indicate the reaction of X_2 with NaBr

10 85 Metal M forms an oxide M_2O having a molecular mass 62 It reacts violently with water. It dissolves in liquid ammonia to give a blue solution.

- (a) What is the atomic mass of M? Write the electronic configuration of M.
- (b) In what group of the periodic table will you place M ?
- (c) Is M a metal ?
- (d) Give an equation to indicate the reaction of M with water.
- (e) Will a solution of M in ammonia conduct electricity?
- (f) Identify M

UNIT 11

Transition Metals Including Lanthanides

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

11.1 Compound of transition elements are generally coloured because they :
- (a) are metallic in nature
- (b) show variable oxidation states
- (c) have partially filled orbitals
- (d) form non-stoichiometeric compounds

11.2 The number of transition metal series is :
- (a) two
- (b) three
- (c) four
- (d) six.

11.3 An important property of the transition metals is :
- (a) the strong metallic bonding that holds the atoms together
- (b) low enthalpies of atomization
- (c) the increase in the radii of the bivalent metal ion with the increase in nuclear charge, for the first row transition metals
- (d) their larger ionic radii than those of the representative elements of the same period.

11.4 The general electronic configuration of the d-block elements is :
- (a) $ns^{1-2} (n+1)d^{1-9}$
- (b) $(n-1)d^{1-9} ns^{1-2}$
- (c) $ns^{1-2} nd^{1-9}$
- (d) $(n-1)d^{1-9} ns^{0}$

11.5 $(n-1)d^{10}ns^{2}$ is the general electronic configuration of
- (a) Fe, Co Ni
- (b) Sc, Y, La
- (c) Zn, Cd, Hg
- (d) Cu, Ag, Au

11.6 Identify the incorrect statement from the following
(a) Transition metals form white compounds also.
(b) Transition metals have partially filled d orbitals
(c) The ionic radii of the transition metals are smaller than those of the representative elements of the same period
(d) In the 3d series the electronic configuration $3d^4\ 4s^2$ is stable.

11.7 $K_2Cr_2O_7$ and K_2CrO_4 :
(a) have Cr in different oxidation state
(b) have same stability in acid solution
(c) can be obtained directly by the fusion of chromite ore ($FeCr_2O_4$)
(d) have crystals of different colours.

11.8 $CuCl_2$ is .
(a) ionic
(b) an ionic aggregate
(c) a covalent monomer
(d) covalent consisting of infinite chain.

11 9 Potassium permanganate :
(a) is a strong oxidising agent in the acid medium only
(b) is prepared from pyrolusite
(c) can be electrochemically oxidised to potassium manganate
(d) is used in dry cells.

11.10 Magnetic moment of a paramagnetic compound
(a) decreases as the number of unpaired electrons increases
(b) increases as the number of unpaired electrons increases
(c) decreases with the increase in the number of valence electrons
(d) increases with the increase in the number of valence electrons.

11 11 The correct order of the increasing acidity of the three oxides of chromium is
(a) $CrO < Cr_2O_3 < CrO_3$
(b) $Cr_2O_3 < CrO < CrO_3$
(c) $CrO_3 < CrO < Cr_2O_3$
(d) $CrO_3 < Cr_2O_3 < CrO$

11 12 Coinage metals are :
(a) iron, ruthenium, osmium
(b) nickel, palladium, platinum
(c) copper, silver, gold
(d) cobalt, rhodium, iridium.

11.13 The inner transition metals are not :
(a) the lanthanides and actinides
(b) the first and second series of rare earth
(c) characterised by filling of 4f and 5f
(d) characterised by filling of 4d and 5d orbitals in their atoms

(B) Completion Type

Complete the following .

11.14 The highest oxidation state shown by any transition metal is ________ .

11.15 The horizontal similarities in the properties of the transition metals is ________________ than those in the main group elements.

11.16 Except scandium the most common oxidation state of the first row transition elements is___(i)___ . This arises due to the loss of two____(ii)____electrons. Thus, after scandium the ____(iii)____ orbitals become more stable than the ____(iv) orbitals.

11.17 The inner transition series consists of the ____(i)____ and the ____(ii)____ .

11.18 Becuase of the weak shielding of the nucleus by 4f electrons, the first ioinization energies of 5d elements is ____________ than those of the 3d and 4d elements

11.19 The transition metals show variable valency. They show the highest oxidation states in their ____(i)____ and ____(ii)____.

11.20 Potassium manganate is ________ electrochemically to permanganate.

11.21 In $Ni(CO)_4$, the oxidation state of Ni is __________.

11.22 The ionic radii of the transition metals are _________ than those of the main group elements.

11.23 A few transition metal ions are colourless, because their orbitals are either____(i)____or ____(ii)____.

11.24 The basic and amphoteric transition metal oxides dissolve in non-oxidizing acid to form __________ such as $[M(H_2O)_6]^{n+}$

11.25 Generally the transition metal oxides are ____(i)____ when the metal is in low oxidation state and ____(ii)____ when the metal is in high oxidation

11.26 Diamagnetic substances are ____(i)____ by an applied magnetic field, while paramagnetic substances are ____(ii)____ by an applied magnetic field

11.27 Bonding in CuF_2 is ____(i)____ whereas $CuCl_2$ is ____(ii)____ consisting of infinite chains.

11.28 Many of the actinides being ___________ accessibility of their compound for laboratory study is limited.

11.29 (a) $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow$ __________ $+ 7H_2O$

(b) $2CrO_4^{2-} + 2H^+ \rightleftharpoons$ ____(i)____ $\rightleftharpoons$ ____(ii)____ $+ H_2O$

(c) $MnO_4^- + 2H_2O + 3e^- \xrightarrow[\text{medium}]{\text{alkaline}}$ __________ $+ 4OH^-$

(d) $MnO_4^- + 8H^+ + 5Fe^{2+} \longrightarrow 5Fe^{3+} +$ __________ $+ 4H_2O$

(e) $TiCl_4 + 2H_2O \longrightarrow$ __________ $+ 4HCl$

(C) True or False Type

Classify the following statements as true (T) or false (F) :

11.30 Because of lanthanide contraction the chemical properties of the lanthanides vary slightly. This is exploited in the individual separation of these elements

11.31 All transition elements show variable oxidation states.

11.32 The stability of a given oxidation state depends on the nature of the transition metal and not on the nature of the element with which it is combined.

11.33 CrO_4^{2-} has a square planar structure with the four oxgyen atoms placed at the four corners of the square.

11.34 With increase in the atomic number for the lanthanide elements, there is a steady increase in their radii

11.35 As an effect of the lanthanide contraction, the elements of the next two groups after the lanthanides possess about the same atomic radii.

11.36 Ferromagnetism is a special type of paramagnetism.

11.37 The paramagnetic characteristics of the transition metal ions increase as the number of unpaired electrons decreases.

11.38 Being highly reactive, halogens react with transitional metals at room temperatures.

11.39 In acidic medium, CrO_4^- dimerises to form $Cr_2O_7^{2-}$.

11.40 Dichromates are prepared directly by the fusion of chromite ore

11.41 The atomic sizes of the transition metals are very similar and hence in the crystal lattice, atom of one metal can be easily replaced by atom of another metal, producing an alloy.

11.42 The basic and amphoteric oxides of transition metals dissolve in oxidising acids.

11.43 Transition metals react with all halogens to form ionic halides

11.44 All halogens can oxidise transition metals to their highest oxidation states.

11.45 Sulphides are generally formed, with metals in lower oxidation states since sulphur is not a good oxidising agent

(D) Matching Type

Match the items in List A with items in List B by indicating the serial number of the item in List A against the relevant items in List B:

11.46

LIST A		LIST B	
	Compound		*Characteristic*
(a)	$K_2Cr_2O_7$	(i)	colourless
(b)	MnO_2	(ii)	primary standard

(c) Cu^+
(d) $Ni(CO)_4$

(iii) interstitial alloy
(iv) metal in zero oxidation state
(v) used in dry cell

11.47

LIST A
Family of elements
(a) alkaline earth
(b) coinage metals
(c) lanthanides
(d) alkali metals

LIST B
Electronic configuration
(i) ns^2
(ii) ns^1
(iii) $(n-1)d^{10}\ ns^1$
(iv) ns^2np^6
(v) $(n-2)f^{1-14}\ (n-1)d^{1\ 9}\ ns^2$

II. SHORT-ANSWER TYPE ITEMS

11.48 In the first row transition metals, why do the radii of the bivalent metal ions generally decrease with increase in nuclear charge?

11.49 The highest oxidation state of an element is normally exhibited by its flourides and oxides Justify the statement.

11.50 The most common oxidation state of the first row transition metals is + 2. What does this signify?

11.51 The ionic radii of transition metals is smaller than those of the representative elements of the same period. Why?

11.52 Why are transition metals good catalysts? Name at least two important industrial processes where transition metals are used as catalysts

11.53 What is meant by the term 'lanthanide contraction'?

11.54 Predict the *d*-orbital occupancy/vacancy of colourless transition metal ion.

11.55 What are interstitial compounds?

11.56 What are paramagnetic substances? What is the unit of magnetic moment?

11.57 What is the structure of a dichromate ion?

11.58 Name the most important oxide of Mn. Does it occur in nature?

11.59 What is the structure of $CuCl_2$?

11.60 Which transition metals are known as the ferrous metals and the coinage metals?

11.61 Why are rare earths added to steel?

11.62 Outer electronic configuration of the lanthanide europium is $4f^7\ 5d^0\ 6s^2$ and that of the next element gadolinium is $4f^7\ 5d^1\ 6s^2$. Similarly, ytterbium and lutetium — two lanthanides which also differ in atomic number by 1, have electronic configurations of $4f^{14}\ 5d^0\ 6^2$ and $4f^{14}\ 5d^1\ 6^2$. Why?

11.63 Why are the chemical properties of the lanthanides similar?

11.64 What is the general method of synthesis of the transuranic (man made) elements?

III LONG-ANSWER TYPE ITEMS

11.65 Define the term 'transition element'. What are their main characteristics? Discuss the status of zinc with reference to your definition.

11.66 Use, if necessary, the following electrode potential data to answer the questions given below :

(i) $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ + 1.31 V

(ii) $MnO_4^- + e^- \rightarrow MnO_4^{2-}$ + 0.54 V

(iii) $CrO_4^{2-} + 4H_2O + 3e^- \rightarrow Cr(OH)_3 + 5(OH)^-$ − 0.12 V

(iv) $MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$ + 1.69 V

(v) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ + 1.52 V

(vi) $\frac{1}{2}Cl_2 + e^- \rightarrow Cl^-$ + 1.36

(a) In alkaline medium both chromate and dichromate ions contain chromium in oxidation state +6. Can both be used as oxidizing agents for chloride ions? Justify your answer.

(b) The conversion of CrO_4^{2-} to $Cr_2O_7^{2-}$ can be brought about by adding a mineral acid to the former, but MnO_4^{2-} is usually converted to MnO_4^- by electrochemical process Explain why.

(c) Aqueous solutions of both $K_2Cr_2O_7$ and $KMnO_4$ act as oxidizing agents in acidic medium and are used to carry out redox titrations. H_2SO_4 is generally used to acidify the titrant. On the basis of the redox potential data given above suggest whether HCl or an organic acid can be used in place of H_2SO_4.

11.67 Why are transition metal ions usually coloured? However, why is Cu^+ salt generally white?

11 68 What are alloys and interstitial compounds?

11.69 Why is lanthanide contraction caused? Do you think that contraction exist in the series following scandium?

11 70 Explain why different number of electrons in the 'f' orbital does not affect the chemical properties as much as the different number of electrons in the *d*-orbitals of transition element.

UNIT 12

Coordination Compounds and Organometallics

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer :

12.1 The IUPAC name for $K_3[Fe(C_2O_4)_3]$ is :
- (a) potassium trioxalatoferrate (III)
- (b) tripotassium trioxalotoiron (III)
- (c) trioxalato potassiumferrate (III)
- (d) potassium iron (III) trioxalate.

12.2 The IUPAC name for $[Co(NH_3)_6]Cl_3$ is
- (a) cobalt hexammine trichloride
- (b) cobaltaminochloride
- (c) hexamminecobalt chloride
- (d) hexamminecobalt (III) chloride

12.3 The IUPAC name of $[Pt(NH_3)_2Cl_2]$ is :
- (a) platinum diamminodichloride
- (b) diammioplatinum (II) dichloride
- (c) platinodiamine dichloride
- (d) dichlorodiammineplatinum(II).

12.4 Which of the following cannot act as a ligand ?
- (a) NH_3
- (b) H_2O
- (c) CO
- (d) CH_4

12.5 Which of the following is the coordination isomer of $[Cr(en)_3][Co(CN)_6]$?

(a) $[Cr(en)_2(CN)_2][Co(en)(CN)_4]$

(b) $[Cr(en)(CN)_4][Co(en)_2(CN)_2]$

(c) $[Co(en)_3][Cr(CN)_6]$

(d) None of the above (a,b,c)

12.6 Which of the following is the ionization isomer of $[Co(NH_3)_5Br]^{2+}SO_4^{2-}$?

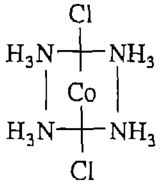
(a) $[Co(NH_3)_5BrSO_4]$

(b) $[Co(NH_3)_5Br(SO_4)]2H_2O$

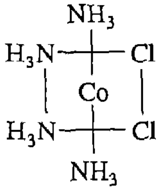
(c) $[Co(SO_4)Br(H_2O)_5]$

(d) $[Co(NH_3)_5SO_4]^+Br^-$

12.7 Given below are the two isomers of a coordination compound



and



The isomerism exhibited is .

(a) linkage isomerism
(b) geometrical isomerism
(c) coordination isomerism
(d) ionization isomerism.

12.8 $[Co(NH_3)_5ONO]Cl_2$ and $[Co(NH_3)_5NO_2]Cl_2$ show :

(a) geometrical isomerism
(b) linkage isomerism
(c) coordination isomerism
(d) ionisation isomerism.

12.9 Which of the following values of "K" corresponds to the most unstable complex compound?

(a) 1.6×10^{-7}
(b) 4.5×10^{11}
(c) 2.0×10^{27}
(d) 5.0×10^{33}

12.10 According to the valence bond scheme as proposed by Pauling, in an octahedral complex the hybridization involved is :

(a) d^2sp^3

(b) sp^3

(c) dsp^2

(d) d^3sp^2

(B) Completion Type

Complete the following :

12.11 The chemical formula for Wilkinson's catalyst is ________.

12.12 Cisplatin which finds use in cancer chemotherapy has the formula ________

12.13 Complexes formed by ligands such as EDTA are known as ________ complexes.

12.14 (a) $PbCl_4 + 4EtMgBr \rightarrow$ ________ $+ 4MgBrCl$

(b) $C_6H_6 + Cr(\text{vapour}) \rightarrow$ ________

(c) $Ni + 4CO \rightarrow$ ________

(d) $NiCl_2 + 6NH_3 \rightarrow$ ________.

(e) $H_2C = CH_2 + PtCl_4^{2-} \rightarrow$ ________ $+ Cl^-$

12.15 EDTA is a ________ dentate ligand.

12.16 Tetrahedral complexes are formed by hybridising one ____(i)____ and three ____(ii)____ orbitals to obtain ____(iii)____ equivalent orbitals oriented tetrahedrally.

12.17 The type of isomerism that occurs when both the cation and the anion are complexes is known as ________ isomerism.

12.18 d^2sp^3 hybridisation generally leads to ________ geometry.

12.19 According to Werner's suggestion metals possess two types of linkages : primary and secondary. The primary linkage is ____(i)____ and the secondary linkage is ____(ii)____.

12.20 The IUPAC nomenclature of $[CoCl(NH_3)_5]Cl_2$ is ________

12.21 The magnitude of the stability constant gives an indication of the ________ of the complexes in solution.

12.22 EDTA is a suitable reagent for the estimation of ____(i)____ of water as the ____(ii)____ values of its complexes with Ca^{2+} and Mg^{2+} are significantly different

12.23 Organometallic compounds are defined as those which contain one or more ________ bonds.

(C) True or False Type

Classify the following statements as true (T) or false (F) ·

12.24 According to Werner metals possess two types of linkages — primary and secondary.

12.25 The primary linkage in metals (as defined in 12.24) is ionizable and secondary linkage is non-ionizable.

12.26 In a few ligands, there exists two possibilities in the mode of attachment to the central metal atom or ion. Complexes with such ligands show coordination isomerism.

12.27 Coordination compounds generally appear to be coloured because they absorb in the entire region of the electromagnetic spectrum.

12.28 Electrical conductance of coordination compounds in solution is often related to the number of ionizable species present

12.29 Wilkinson's catalyst is used for hydrogenation of alkenes

12.30 Cisplatin has found use in cancer chemotherapy

12.31 Ferrocene is a coordination complex of flourene and cerium.

12.32 IUPAC name of $[Pt(NH_3)_2Cl_2]$ is diammineplatinum (II) chloride.

12.33 Complexes with coordination number six, having bidentated ligands cannot show optical isomerism.

(D) Matching Type

Match the items given in List A with relevant answers given in List B by indicating the serial number of item of List A against that of List B.

12.34	LIST A		LIST B
	Name of compound		*Formula*
(a)	Wilkinson's catalyst	(i)	$(C_5H_5)_2$ Fe
(b)	Ferrocene	(ii)	K [Pt Cl_3 (C_2H_4)]
(c)	Zeisse's salt	(iii)	$(Ph_3P)_3RhCl$
(d)	cisplatin	(iv)	$(Et)_4Pb$
		(v)	$[Pt(NH_3)_2Cl_2]$

12.35	LIST A		LIST B
	Shape		*Hybridisation*
(a)	octahedral	(i)	sp^3
(b)	square planer	(ii)	d^2sp^3
(c)	tetrahedral	(iii)	dsp^2
		(iv)	sp^2d^2

12.36 LIST A

Type of isomerism

(a) ionisation isomerism
(b) linkage isomerism
(c) geometrical isomerism
(d) coordination isomerism

LIST B

Shown by

(i) $[Co(NH_3)_5\ NO_2]\ Cl_2$
(ii) $[(Cr(en)_3]\ [Co(CN)_6]$
(iii) $[Co(NH_3)_5SO_4]^+\ Br$
(iv) $[Co\ (en)_3]\ Cl_3$
(v) $[Pt\ (NH_3)_2\ Cl_2]$

II. SHORT-ANSWER TYPE ITEMS

12.37 Mention one use for each of the following ·
(a) Wilkinson's catalyst
(b) tetraethyl lead
(c) Zeigler Natta catalyst
(d) organolithium compounds.

12.38 Differentiate between .
(a) linkage isomerism and ionization isomerism.
(b) d^3sp^2 hybridization and sp^3d^2 hybridization

12.39 Give the IUPAC name of the following complexes
(a) $K_3\ [Fe\ (C_2O_4)_3]$
(b) $Pt\ [(NH_3)_6]Cl_4$
(c) $[CoCl(NH_3)_5]Cl_2$

12.40 Draw the hybridization scheme for d^2sp^3, $sp^3$and dsp^2 hybridized orbitals using 3d, 4s, 4p orbitals.

12.41 Write the formulae for the following complexes ·
(a) dichlorodiamnineplatinum (II)
(b) potassium hexacyanoferrate III
(c) hexammineplatium (IV) chloride
(d) chloropentanminecobalt (III) chloride

12.42 What information does one derive from the stability constant value of a complex ?

12.43 Name the multidentate-ligand used in the estimation of hardness of water. How does it work?

12.44 What are the two broad categories in which organometallic compounds can be categorised? Give an example for each category

12.45 Write a reaction showing oxidative addition of an organic halide to a metal

12.46 What are organometallic compounds? Give one example of a π-complexes

12.47 Name the metal present in each of the following
(a) chlorophyll
(b) haemoglobin
(c) cisplatin

IV LONG-ANSWER TYPE ITEMS

12.48 What are coordination compounds? Discuss their special characteristics.

12.49 What are isomers? Discuss the several isomeric possibilities that may arise in coordination compounds, depending on the position and arrangement of ligands around the metal Give suitable examples.

12.50 With the help of appropriate examples, discuss the simple valence bond scheme of Pauling as applied to coordination compounds.

12.51 Explain with suitable examples the importance of coordination compounds in ·
(a) biological systems
(b) metal analysis
(c) chemical industry

V PROBLEM TYPE ITEMS

12.52 Hydrated cobalt (II) chloride was reacted with concentrated aqueous ammonia and ammonium nitrate in the presence of hydrogen peroxide. The resulting compound was found to have the molecular formula $[Co(NH_3)_5NO_2]Cl_2$.
The compound exhibits isomerism. An aqueous solution of the compound has a conductivity equivalent to that of a compound with three ions per formula unit. Using the above information answer the following questions :
(a) Attempt to write a chemical equation showing the formation of the complex
(b) Write the IUPAC name of the compound.
(c) Name the type of isomerism exhibited by the compound
(d) What is the coordination number of the central metal atom in each of the isomers?
(e) (i) Write the type of hybridization involved
(ii) What is the shape of the complex?

UNIT 13

Nuclear Chemistry

I. OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer

13.1 Radioactive substances show radioactivity
- (a) when they are exposed to sunrays for some time
- (b) when they are kept in total darkness
- (c) when cooled sufficiently
- (d) irrespective of the physical and chemical conditions.

13.2 Emission of a beta particle from a radioactive nucleus produces a daughter element
- (a) with one less proton than the parent nucleus
- (b) with atomic number decreased by 1 unit than the parent element
- (c) which occupies one group to the left of the parent element in the periodic table
- (d) which has the same mass number as the parent element.

13.3 Beta rays have greater penetrating power than the alpha rays of similar energy because .
- (a) beta rays are a stream of electrons with negative charge
- (b) beta rays have negligible mass and consequently very high velocities
- (c) alpha rays are positively charged species carrying 2 units of charge
- (d) alpha rays are attracted by the electron cloud while the beta particles are repelled by the cloud

13.4 Radioactivity of $^{214}_{84}Po$ is more intense than that of $^{238}_{92}U$. The probable reason for this could be:
- (a) polonium has a greater unfavourable neutron to proton ratio than uranium

(b) polonium has an outer electronic configuration of $6s^2\ 6p^4$, while uranium has an outer electronic configuration of $5f^3\ 6d^1\ 7s^2$
(c) polonium is a disintegration product of uranium, nearer to lead
(d) polonium is found in much less amount compared to uranium in nature.

13.5 Which of the following radioactive series contains man-made elements?
(a) Thorium series
(b) Neptunium series
(c) Uranium series
(d) Actinium series

13.6 ${}^{27}_{13}\mathrm{Al}$ on bombardment with neutrons forms ${}^{27}_{12}\mathrm{Mg}$ The nuclear reaction is of the type :
(a) (n, α)
(b) (n, p)
(c) (n, γ)
(d) (n, β)

13.7 ${}^{232}_{90}\mathrm{Th}$ decays to ${}^{228}_{89}\mathrm{Ac}$ The change is brought about by the emission of :
(a) α particles
(b) β particles
(c) γ rays
(d) α particle followed by a β particle.

13.8 The process that accounts for the radioactive process

$${}^{224}_{88}\mathrm{Ra} \rightarrow {}^{208}_{82}\mathrm{Pb} \text{ is}$$

(a) 2 α particles and 3 β particles
(b) 3 α particles and 3 β particles
(c) 4 α particles and 2 β particles
(d) 4 α particles and 3 β particles

13.9 Radioactive disintegration is an example of a .
(a) first order reaction
(b) zero order reaction
(c) fractional order reaction
(d) None of the above (a,b,c).

13.10 The half life period of a radioactive element :
(a) is directly proportional to the disintegration constant
(b) increases with the number of the disintegrating nuclei
(c) decreases with the number of disintegrating nuclei
(d) is a characteristic property of the radioactive nuclei.

13.11 A nuclear fission reaction .
- (a) is believed to take place in the sun and in other stars
- (b) can be represented as

$$ {}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n $$

- (c) is the basis of the thermonuclear bomb
- (d) is one in which a heavy nucleus breaks up into 2 smaller fragments.

(B) Completion Type

Complete the following ·

13.12 (a) Alpha particles carry ____(i)____ units of charge and ____(ii)____ units of mass
- (b) Gamma rays carry ____(i)____ charge and ____(ii)____ mass
- (c) When an alpha particle is emitted, the daughter nuclei occupies two places ____________ of the parent element in the periodic table
- (d) Radioactive disintegration obeys the rate law ____________.
- (e) The half life period of a radioactive element is ____________ of the initial concentration.

13.13 (a) Artificial transmutation of any nuclei is easiest with ____________
- (b) In a reactor ____(i)____ or ____(ii)____ is used to slow down neutrons
- (c) In a reactor ____(i)____ or ____(ii)____ is used to absorb extra neutrons so that the reaction does not become violent.
- (d) In neutron activation analysis, the sample is bombarded with ____(i)____ and the stable isotope of the element is activated into a ____(ii)____
- (e) The reaction considered for controlled thermonuclear fusion to generate power is fusion of ____(i)____ nuclei to from ____(ii)____

13.14 (a) ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th +$ ____________

(b) ${}^{14}_{6}C \rightarrow$ ____________ $+ {}^{0}_{-1}e$

(c) ${}^{234}_{90}Th \rightarrow {}^{234}_{91}Pa +$ ____________

(d) ${}^{238}_{92}U \rightarrow {}^{206}_{82}Pb$ ____________ $+ {}^{0}_{-1}e$

(e) ${}^{9}_{4}\mathrm{Be} + {}^{4}_{2}\mathrm{He} \rightarrow \text{———————} + {}^{1}_{0}\mathrm{n}$

(C) True or False Type

Classify the following statements as true (T) or false (F) :

13.15 (a) Particles emitted by radioactive elements have high ionising power.

(b) Of α , β and γ radiation, the latter has the lowest penetrating power.

(c) Radium, polonium, uranium, thorium are all radioactive elements, but not all of them occur in nature.

(d) Nuclear fission is represented by the equation

$$4\,{}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{0}_{+1}\mathrm{e}$$

(e) All radioactive series ends in Pb (atomic number of lead being 206 or 207 or 208)

13.16 (a) The daughter element is never radioactive

(b) The extent of decay of any radioactive element depends on physical conditions such as temperature, pressure, etc.

(c) The fusion reaction is the basis of the so called hydrogen or thermonuclear bomb

(d) A breeder reactor is one that produces more fissionable nuclei than it consumes.

(e) The moderator in a nuclear reactor is made of boron steel or cadmium.

(D) Matching Type

Match the items given in List A with relevant answer in List B by indicating the serial number of the item of List A against that of List B

13.17

LIST A *Radioactive process*	LIST B *Represented by process*
(a) ${}^{9}_{4}\mathrm{Be}\ (\quad)\ {}^{12}_{6}\mathrm{C}$	(i) (n, p)
(b) ${}^{14}_{7}\mathrm{N}\ (\quad)\ {}^{14}_{6}\mathrm{C}$	(ii) (α, n)
(c) ${}^{7}_{3}\mathrm{Li}\ (\quad)\ {}^{8}_{3}\mathrm{Li}$	(iii) (d, p)
	(iv) (p, n)

13 18

LIST A *Name of scientist*		LIST B *Associated with discovery/ invention*	
(a)	Becquerel	(i)	Polonium
(b)	Curie	(ii)	counter for measuring radioactive decay
(c)	Geiger Muller	(iii)	breeder reactor
(d)	Joliet-Curie	(iv)	artificial radioactivity
		(v)	radioactivity

II. SHORT-ANSWER TYPE ITEMS

13 19 Derive an expression for decay constant of a radioactive substance. State its unit.

13.20 Although natural uranium contains U^{235} which is radioactive, but explosive chain reaction does not develop in uranium ore. Why?

13.21 What is the main difference between a normal chemical reaction and a nuclear reaction?

13 22 Can solar energy be termed as nuclear energy? Explain.

13 23 What is the group displacement law?

13 24 You are given a sample of animal or vegetable origin. How would you estimate the age of the sample?

13 25 A trace of Oxygen-18 was incorporated into an ester by exchange with the etherial oxygen. It was then hydrolyzed by adding a small amount of HCl. The alcohol carried the labelled oxygen What conclusions can be drawn out of it?

13.26 $^{206}_{82}Pb$ is formed by disintegration of a radioactive substance (X) through emission of 5 alpha particles and 4 beta particles successively. What is the atomic number and the atomic mass of X?

III. LONG-ANSWER TYPE ITEMS

13 27 What is meant by half life period of a radioactive element ? What information can be obtained from its determination?

13.28 What is artificial radioactivity? Outline its usefulness to humanity.

13 29 What is nuclear fission? How is it used for generating power?

13 30 What is carbon dating? Illustrate the importance of the technique

13 31 Outline the basic principle involved in the functioning of a nuclear reactor. Where in India do we have nuclear power plants?

13 32 What is the difference between nuclear fission and nuclear fusion? Illustrate with examples. In what unit is fusion energy expressed?

IV NUMERICAL PROBLEMS

13.33 The radioactivity of a radioelement changes from initial value of 4000 disintegrations per minute to 1000 disintegrations per minute in 42 days. Determine the disintegration constant

13.34 The half-life period of a certain radioelement is 14.8 hours. What will be the time required for its initial concentration to fall by 10%?

13.35 A sample of wood used in a table has only 8% of Carbon-14 activity left as compared to a freshly cut piece of wood. The half-life period of Carbon-14 is 5760 years. What is the age of the table?

13.36 The half-life period of a radio isotope is one hour. If you started working with 0.32 grams of the isotope at 9 a.m in the morning, how much of the isotope would be left at 5 p.m the same day?

13.37 Calculate the energy released in the reaction :

$$2\,{}_{1}^{1}H + 2\,{}_{0}^{1}n \rightarrow {}_{2}^{4}He$$

Given, mass of proton = 1.00813 amu
mass of neutron = 1.00897 amu
mass of helium nucleus = 4.0038 amu
1 amu = 931 Mev

13.38 Calculate the age of an uranium ore that contains 0.277g of an ^{206}Pb for every 1.667g of ^{238}U. The half-life period of ^{238}U is 4.5×10^9 years (Assume the half lives of intermediate daughter nuclei to be negligible.)

13.39 (i) How much of C_8H_{18} (gasoline) would be required to release the same amount of energy as that released when one gram of ^{235}U undergoes fission? Given :

(a) $C_8H_{18}\,(l) + 12\frac{1}{2}\,O_2 \rightarrow 8CO_2\,(g) + 9\,H_2O\,(l)\quad \Delta H = -5470$ kJ.

(b) Energy released when one gram of ^{235}U undergoes fission is 8.4×10^7 kJ.

(c) Speed of light is $3 \times 10^8 ms^{-1}$

(ii) What would be the loss in mass during the fission?

UNIT 14

Synthetic and Natural Polymers

I. OBJECTIVE TYPE ITEMS

(A) **Multiple Choice**

Write the correct answer:

14.1 Select the condensation polymer from among the following :
- (a) polythene
- (b) PTFE
- (c) polybutadiene
- (d) alkyd resin.

14.2 Which one of the following represents synthetic rubber?
- (a) polydiene such as neoprene
- (b) polyvinyl chloride
- (c) polytetrafluoroethylene
- (d) polymethylmethacrylate (PMMA).

14.3 Nylon-66 is a condensation polymer of .
- (a) terepthalic acid and ethylene glycol
- (b) phenol and formaldehyde
- (c) hexamethylene diamine and adipic acid
- (d) tetrafluoro ethylene.

14.4 Natural polymer amongst the following is .
- (a) polyethylene
- (b) polystyrene
- (c) polypropylene
- (d) polyisoprene.

14.5 Condensation polymerisation :
- (a) always involves monomers derived from ethene
- (b) produces polymers which have the same empirical formula as their monomer
- (c) always involves monomers that are unsaturated
- (d) involves reactions between monomers resulting in the loss of small molecules usually water.

14.6 Which of the following is used as an initiator in a chain growth polymerisation?
- (a) sulphur
- (b) CCl_4
- (c) benzoyl peroxide
- (d) toluene

14.7 Elastomers are characterised by :
- (a) strong intermolecular force
- (b) their ability to be stretched
- (c) their crystalline nature
- (d) extensive cross-linking resulting in three-dimensional network.

14.8 Fibres are characterised by :
- (a) their weak intermolecular forces
- (b) their ability to be stretched
- (c) their sharp melting points
- (d) extensive cross-linking resulting in three-dimensional network

14.9 Thermoplastics are characterised by :
- (a) their very weak intermolecular forces
- (b) their ability to be moulded by heating
- (c) their very strong intermolecular forces
- (d) their extensive cross-linking resulting in three-dimensional network.

14.10 Thermosetting polymers are characterised by.
- (a) their ability to be moulded by heating
- (b) their ability to be stretched
- (c) their sharp melting point
- (d) extensive cross-linking resulting in three-dimensional network

14 11 The product of the reaction :

$$nH_2N(CH_2)_6NH_2 + nHOOC(CH_2)_4COOH \text{ is } \cdot$$

- (a) nylon-66
- (b) terylene
- (c) bakelite
- (d) nylon-6.

14.12 Which of the following can be termed a phenol-formaldehyde resin?
- (a) nylon-66
- (b) bakelite
- (c) polystyrene
- (d) PVC

14.13 Which one of the following is Teflon?
- (a) polyethylene
- (b) PVC
- (c) PTFE
- (d) polybutadiene

14.14 Which of the following is a polydiene?
- (a) Buna-S
- (b) PVC
- (c) PMMA
- (d) bakelite

14.15 The commercial name of PMMA is :
- (a) Buna-S
- (b) Teflon
- (c) bakelite
- (d) plexiglass.

14.16 In Buna-S, the letter S stands for :
- (a) synthetic
- (b) sodium
- (c) sulphur
- (d) styrene.

14.17 Terelyne is not :
- (a) a polyster
- (b) a polymer of ethylene glycol and terepthalic acid
- (c) the same as decron
- (d) an addition polymer.

(B) Completion Type

Complete the following :

14.18 (a) Three examples of inorganic polymers are ___(i)___, ___(ii)___ and ___(iii)___

(b) Protein is a polymer obtained by polymerisation of ________

(c) ________ polymers have the same empirical formula as their monomers

(d) ___(i)___ polymerisation results in the loss of small molecules usually ___(ii)___.

(e) Chain growth polymerisation requires ___(i)___ to produce ___(ii)___ to which monomers are added in a chain fashion.

14.19 (a) When classified on the basis of the magnitude of intermolecular forces present in them, elastomers are found to have ________ intermolecular force.

(b) ________ polymers have extensive cross-linking between different polymer chains forming three-dimensional network of bonds connecting these chains

(c) The starting raw material for nylon-66 are ___(i)___ and ___(ii)___

(d) Polydienes are synthetic rubbers, e.g neoprene and ________

(e) Nylon-6 is obtained by polymerisation of ________.

(C) True or False Type

Classify the following statements as true (T) or false (F) :

14.20 (a) Protein is a polymer of amino acids.
- (b) Polymerisation is the process by which the polymers are transferred into monomers.
- (c) Polymers can only be made from organic molecules
- (d) Addition polymerisation usually involves the monomers of saturated compounds
- (e) Teflon is obtained by step growth polymerisation.

14.21 (a) Vulcanised rubber is a fibre.
- (b) Polyacrylonitrile is also known as Acrilan.
- (c) Nylon-66 is an addition polymer.
- (d) Nylon-6 is a polymer of caprolactam
- (e) Lucite is natural rubber.

(D) Matching Type

Match the items given in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B.

14.22

LIST A	LIST B
Commercial name	*Polymer of*
(a) PVC	(i) caprolactam
(b) Buna-S	(ii) tetrafluoroethylene
(c) Terylene	(iii) ethylene glycol and terepthalic acid
(d) Teflon	(iv) acrylonitrile
(e) Acrilan	(v) vinyl chloride
	(vi) butadiene and styrene
	(vii) chloroprene

14.23

LIST A	LIST B
Polymer	*Belongs to the category of*
(a) polysaccharide	(i) condensation polymer
(b) nylon-66	(ii) chain growth polymer
(c) PVC	(iii) polydiene
(d) Buna-S	(iv) phenol formaldehyde resin
(e) Bakelite	(v) natural polymer
	(vi) alkyd resin

II. SHORT-ANSWER TYPE ITEMS

14.24 What is the difference between nylon-6 and nylon-66? What do 6 and 66 stand for?

14.25 Give two examples each of natural and synthetic polymers.

14.26 Differentiate between chain growth polymerisation and step growth polymerisation

14.27 Fibres are of crystalline nature. Why?

14.28 What does the name Buna-S stand for?

14.29 What is the monomer of natural rubber?

14.30 The intermolecular forces are more significant in macromolecules. Why?

14.31 Differentiate between thermoplastic and thermosetting polymers.

14.32 Give two examples of polyolefines and state two uses of each

14.33 Name the monomers in each of the following polymers.

- (i) neoprene
- (ii) PVC
- (iii) glyptal
- (iv) nylon-66

14.34 How is bakelite prepared? State two of its uses.

14.35 Write the full form of the following abbreviations :

- (a) PVC
- (b) PMMA
- (c) PTFE
- (d) PCTFE

14.36 Explain the following terms with examples

- (i) polyesters
- (ii) macromolecules

14.37 What is meant by the terms :

- (a) chain growth polymerisation
- (b) initiator
- (c) step growth polymerisation

14.38 Name the polymer :

- (i) which is used in making plastic crockery
- (ii) which is used as a bonding glue for laminated wooden planks

III. LONG-ANSWER TYPE ITEMS

14.39 How can the polymers be classified .

- (a) based on their methods of synthesis
- (b) based on molecular forces? Give examples wherever possible

14.40 What are addition polymers? Give examples of 4 different types of such polymers.

14.41 What are condensation polymers? Give examples of 3 different types of such polymers

14.42 Discuss the formation of bakelite from phenol and formaldehyde. Write the necessary equations for the formation of melamine polymer.

14.43 Discuss the importance of polymers in everyday life.

14.44 How is the method for expressing molecular mass of natural and synthetic polymers different? Why is this difference?

14.45 Give two examples each of the following category of commercially important polymers and state the name of the constituent monomers in each case .

(a) polyolefins
(b) polydienes
(c) polyacrylates
(d) polyhalo-olefines
(c) polyesters
(f) polyamides

UNIT 15

Surface Chemistry

I OBJECTIVE TYPE ITEMS

(A) **Multiple Choice**

Write the correct answer

15.1 The substance being adsorbed is called the :
- (a) adsorbent
- (b) adsorbate
- (c) desorbate
- (d) absorbate

15.2 Which of the following combination does not form a colloidal system?
- (a) gas in liquid
- (b) liquid in liquid
- (c) solid in solid
- (d) gas in gas

15.3 When light passes through a sol, its path becomes visible because the light gets :
- (a) reflected
- (b) scattered
- (c) dispersed
- (d) refracted

15.4 Physisorption :
- (a) is associated with high heat of adsorption
- (b) usually occurs at high temperature
- (c) involves van der Waals interaction between the absorbate and the surface
- (d) is irreversible

15.5 Adsorption isobar :
- (a) is a plot of amount adsorbed $\left(\frac{x}{m}\right)$ against pressure at constant temperature, where x is the mass of the adsorbate, m the mass of the solid adsorbent.

(b) is given by the equation $\left(\frac{x}{m}\right) = kp^{\frac{1}{n}}$, where p is the pressure, n can take any value, x and m are same as in (a) above.

(c) is given by the equation $\left(\frac{x}{m}\right) = kp^{\frac{1}{n}}$, where c is concentration of the solute, x, m and n are same as in (a) and (b) above.

(d) is a plot between amount adsorbed $\left(\frac{x}{m}\right)$ versus temperature at constant pressure.

15.6 Colloidal system is
- (a) same as true solution
- (b) same as true suspension
- (c) always heterogeneous
- (d) always homogeneous.

15.7 Lyophilic sols are self-stabilized because between the suspended particles and the dispersion medium there exist :
- (a) strong attractive forces
- (b) no attractive forces
- (c) weak attractive forces
- (d) hydrogen bondings

15.8 Sols of metals are example of :
- (a) lyophobic sols
- (b) lyophilic sols
- (c) emulsions
- (d) reversible sols.

15.9 Micelles have the characteristic of :
- (a) exhibiting colloidal properties at low concentrations
- (b) not being capable of forming ions at any concentration
- (c) being associated colloids
- (d) being strong electrolytes at high concentration

15.10 Colloids have the property of :
- (a) settling down quickly under the force of gravity on keeping
- (b) having high rates of diffusion
- (c) having small surface areas when compared to particles in true solution
- (d) moving in a zigzag path.

15.11 When light passes through a sol, its path becomes visible. This phenomenon is called :
- (a) Brownian motion
- (b) peptization
- (c) Tyndall effect
- (d) electrodialysis

15.12 An emulsion is formed when :

(a) a liquid is dispersed in a gas
(b) a liquid is dispersed in a liquid
(c) a gas is dispersed in a liquid
(d) a gas is dispersed in a solid.

15 13 Fog is a colloidal system where the dispersed phase and dispersed medium are respectively .

(a) liquid ; liquid
(b) gas ; liquid
(c) liquid ; gas
(d) solid , gas.

(B) Completion Type

Complete the following :

15 14 In chemisorption the extent of adsorption first increases with increase in temperature and then decreases. This is because chemisorption requires some ________ just as ordinary chemical reaction.

15 15 Adsorption isotherm in case of adsorption of gases is given by the expression $\log\left(\frac{x}{m}\right) = \log k +$ ________, where $\left(\frac{x}{m}\right)$ is the amount of gas adsorbed, k is a constant

15.16 A graph between extent of adsorption against temperature at constant pressure is called an ________.

15 17 Silica gel is used for adsorption of ________ from air.

15.18 The adsorption isotherm for adsorption of solutes from solution by solid adsorbents is given by the expression $\frac{x}{m} =$ ________, where $\frac{x}{m}$ represents the amount of solute adsorbed

15.19 A colloidal system consists of two phases : the __(a)__ and the __(b)__.

15 20 The nature of adsorption isobar can be used to distinguish physical adsorption from ________ .

15.21 In ________ type of colloids the dispersed particles are themselves large molecules.

15.22 Dialysis is a process of removing ________ from the colloidal solutions

15 23 Emulsions are of two types __(a)__ type, and __(ii)__ type.

15 24 Two significant aspects of heterogeneous catalysis are activity and ________

15 25 Shape selective catalysis depends on the ________.

15.26 Systems which have liquid as the dispersed phase and solid as the dispersion medium are called ________

15.27 Motion of colloidal particles in a zigzag path is called the ________.

15.28 Heterogeneous catalysis is also known as ________.

15.29 Molecules of soap and detergents consist of lyophilic as well as ________ parts.

15.30 In a colloidal solution both the dispersed phase and the dispersion medium cannot be in the ________ phase

15.31 Aerosols of solids are colloidal suspension of solids as dispersed phase in ________

15.32 Cellulose nitrate is peptized by organic solvent such as ethanol to give a product commercially known as ________

(C) True or False Type

Classify the following statements as true (T) or false (F)

15.33 The quantity of an adsorbed gas generally increases with the increasing surface area of the adsorbent

15.34 As compared to molecular solutes, colloidal particles have higher rates of diffusion.

15.35 In case of physical adsorption, the extent of adsorption $\left(\frac{x}{m}\right)$ increases with increase in temperature.

15.36 Compared to lyophilic sols, lyophobic sols are relatively less stable

15.37 Dispersion media (liquids) break up certain substances into colloidal state This process is referred to as peptization

15.38 Sodium stearate dissolves in water to give sodium ion and stearate ions. It is the sodium ions that associate to form ionic micelles of colloidal size

15.39 Emulsions are liquid-liquid colloidal dispersions

15.40 Reactions in zeolites depend on the size of the cavities and apertures present in them.

15.41 To avoid precipitation, stabilizing agents need to be added to lyophilic sols

15.42 The type of charge on the colloidal particles can be determined by electrophoresis.

15.43 Catalysts are always crystalline substances

15.44 Colloidal solutions exhibit no osmotic pressure.

(D) Matching Type

Match the items given in List A with relevant answers given in List B by indicating the serial number of the item in List A against that of List B.

15.45

	LIST A *Concept*		LIST B *Example*
(a)	macromolecular colloids	(i)	breaking up of certain substances by the dispersion media into colloids
(b)	dialysis	(ii)	movement of colloidal particles under the influence of an electric field
(c)	electrophoresis	(iii)	removal of electrolytes from colloids
(d)	emulsion	(iv)	polymers
		(v)	liquid-liquid colloidal dispersion

15.46

	LIST A *Colloidal system*		LIST B *Example*
(a)	solid sol	(i)	butter
(b)	gels	(ii)	pumice-stone
(c)	solid foam	(iii)	ruby glass
(d)	aerosols of liquid	(iv)	most paints
		(v)	soap suds
		(vi)	fog

III SHORT-ANSWER TYPE ITEMS

15.47 Explain the terms 'adsorbent' and 'adsorbate'.

15 48 What is desorption?

15 49 What are adsorption isotherms?

15 50 How is adsorption classified?

15 51 Differentiate between adsorption and absorption

15.52 How does a colloidal solution differ from a true solution?

15 53 Differentiate between sol and emulsion in terms of dispersed phase and dispersion medium

15 54 What are gels? Give two examples

15 55 What is collodion?

15 56 What are the basic types of emulsions?

15.57 What is demulsification? Name two methods of demulsification.

15.58 What is observed when: (i) a beam of light is passed through a colloidal solution, (ii) electric current is passed through a colloidal solution?

15.59 What is meant by :
   (a) Brownian movement
   (b) Tyndall effect?

15.60 What are micelles? Give an example

15.61 Give two physical methods for the preparation of colloidal solutions.

15.62 What are hydrophilic and hydrophobic sols? Give an example of each.

15 63 What is shape selective catalysis?

15.64 What is meant by heterogeneous catalysis and homogeneous catalysis? Give examples.

III LONG-ANSWER TYPE ITEMS

15 65 (a) What is meant by the term 'adsorption'?
   (b) Give the basic characteristics of adsorption.
   (c) Differentiate between physisorption and chemisorption in terms of heat of adsorption.
   (d) What are adsorption isotherm and adsorption isobar? Give appropriate equations for these quantities for adsorption of gases and adsorption from solutions Explain each term in the equations.
   (e) What is meant by the term 'specific surface area of a solid'?

15 66 (a) What is a colloidal solution?
   (b) What are the characteristics of a colloidal solution?
   (c) What are multimolecular colloids, macromolecular colloids, and associated colloids? Give their characteristics and at least one example of each
   (d) How are colloids prepared and purified?

15 67 (a) What are emulsions? Give examples.
   (b) What are the different types of emulsions?
   (c) How are emulsions prepared?
   (d) What role does an emulsifying agent play?

15 68 (a) Discuss the phenomenon of catalysis with suitable examples, wherever needed.
   (b) What are heterogeneous and homogeneous catalysts? Give one example of each. How does a heterogeneous catalyst work?
   (c) Explain the term activity and selectivity of catalysts
   (d) Discuss the role of zeolites as catalysts.

IV NUMERICAL PROBLEMS

15.69 The following data is obtained for the adsorption of acetic acid in charcoal at room temperature.

[acid] (M)	0.05	0.10	0.50	1.0	1.5
$\left(\frac{x}{m}\right)$	0.04	0.06	0.12	0.16	0.19

(a) Show that the above data satisfies the equation

$$\frac{x}{m} = kc^{\frac{1}{n}}$$

(b) Find the value of k and n

15.70 The limiting value of volume of H_2 adsorbed per gram of Cu powder is found to be 1.36 cm^3 at STP If the surface area of H_2 molecule is 1.58×10^{15} cm^2, find the specific surface area of copper powder

UNIT 16

Biomolecules: Structure and Functions

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer :

16.1 α glucose and β glucose .
- (a) have identical melting points
- (b) are anomers
- (c) cannot be interconverted when dissolved in water
- (d) have identical optical rotation.

16.2 The number of monosaccharide units that can be formed by hydrolysis of sucrose will be ·
- (a) 1
- (b) 2
- (c) 3
- (d) None, since no hydrolysis is possible.

16 3 The main storage polysaccharide or food reserve in plants is
- (a) starch
- (b) cellulose
- (c) glycogen
- (d) glucose.

16.4 Starch is a .
- (a) polymer of β glucose
- (b) short-term food reserve in animals
- (c) polymer consisting of two components : amylose and amylopectin
- (d) disaccharide.

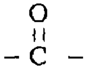
16.5 Cellulose is a polymer of :
- (a) β glucose
- (b) α glucose
- (c) α glucose and β glucose

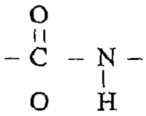
(d) None of the above, as cellulose is not a polymer.

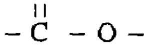
16.6 The type of linkage present in polysaccharides is :
(a) amide
(b) glycosidic
(c) ether
(d) ester.

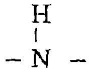
16.7 The major structural polysaccharide in higher plants is :
(a) cellulose
(b) glucose
(c) ribose
(d) sucrose.

16.8 The structure of a peptide linkage is represented as :

(a) 
$-\overset{\overset{O}{\|}}{C}-$

(b) 
$-\overset{\overset{O}{\|}}{C}-\underset{\underset{H}{|}}{N}-$

(c) 
$-\overset{\overset{O}{\|}}{C}-O-$

(d) 
$-\overset{\overset{H}{|}}{N}-$

16.9 The simplest of the amino acids is :
(a) leucine
(b) glycine
(c) alanine
(d) valine.

16.10 A peptide bond consists of a
(a) glycosidic linkage
(b) hemiacetal linkage
(c) acetal linkage
(d) amide linkage.

16.11 Ovalbumin and casein are :
(a) muscle proteins which provide mechanical movement
(b) enzymes which bind substrates to modify them chemically
(c) antibody proteins which bind foreign proteins for polysaccharides
(d) simply present as food reserve.

16.12 Identify the characteristic property of enzymes from the following :
(a) Enzymes belong to the class of lipids.

(b) Enzymes are present in the body as food reserve.
(c) Enzymes are essential biological catalysts.
(d) Enzymes are non-specific in their action on substrates

16 13 The action of enzymes can be best described as :
(a) Enzymes are of very general nature in their action on substrates.
(b) Enzymes cannot be inhibited in their catalytic action.
(c) Enzymes are unable to regenerate themselves during their catalytic activity.
(d) Enzymes are capable of speeding up biochemical reactions.

16.14 Even small amounts of enzymes can be highly efficient. This is because the enzyme molecules :
(a) speed up reactions up to million times compared to uncatalyzed reactions
(b) are very specific in their action on substrates
(c) are active at moderate temperatures and pH
(d) are regenerated sometimes even a million times during their catalytic activity

16 15 Which of the following enzymes is used to dissolve blood clot in the coronary artery ?
(a) phenylalanine
(b) tyrosinase
(c) streptokinase
(d) rennin.

16 16 The base that is found only in nucleotides of RNA is
(a) uracil
(b) thymine
(c) guanine
(d) adenine.

16.17 Oils are converted to fats through the process of :
(a) dehydration
(b) hydrolysis
(c) oxidation
(d) hydrogenation.

16.18 Mutation is defined as :
(a) a process which involves copying of DNA sequences into a complementary RNA molecule
(b) a process in which the two strands of DNA helix unwind and each strand serves as a template for the synthesis of a new strand
(c) the relation between the nucleotide triplets and the amino acids
(d) a chemical change in DNA molecule that leads to synthesis of proteins with an altered amino acid sequence.

(B) Completion Type

Complete the following :

16 19 Maltose is an example of a _________ saccharide.

16 20 Cellulose is a linear polymer of __________

16.21 The human body can synthesise _____(i)_____ out of the total number of _____(ii)____amino acids found in proteins

16 22 Disruption of the native conformation of a protein is called ________

16.23 The monomeric units of nucleic acids are called the ________.

16 24 The bases derived from purine are____(i)____, and____(ii)____

16 25 The two important functions of nucleic acids are ____(i)____, and____(ii)____

16 26 Each triplet of nucleotide in mRNA is called a _________.

16 27 The relation between the nucleotide triplets and the amino acids is called the _________

16 28 DNA consists of two strands of polynucleotides coiled around each other in the form of a ________

16 29 A chemical change in a DNA molecule that could lead to synthesis of proteins with an altered amino acid sequence is called __________.

16 30 The letter m in mRNA stands for __________.

16.31 Lipids which yield alcohol, fatty acids and other compounds on hydrolysis are called __________.

16 32 The simplest and the most abundant lipids are the __________.

(C) True or False Type

Classify the following items as true (T) or false (F)

16 33 Cellulose is a polymer

16 34 Enzymes are active at any temperature

16 35 Lipids are always solids

16.36 Proteins consist exclusively of D optical isomers of amino acids.

16 37 Starch is a polysaccharide

16 38 Sucrose hydrolyses to give glucose and fructose

16 39 Waxes are esters of lower fatty acids and simple alcohols

16.40 In phospholipids, the phosphate group forms the hydrophilic head of the molecule.

16 41 The anomers of glucose differ only in their orientation of the hydroxyl group at the carbon atom (C-1).

16 42 Wood is a combination of cellulose and lignin

16.43 Enzyme tyrosinase dissolves blood clots.

16.44 The shape of a protein is derived from its secondary and tertiary structure.

(D) Matching Type

Match the items given in List A with relevant answers given in List B, by indicating the serial number of the item of List A against that of List B.

16.45

	LIST A		LIST B
	Compound		*Type*
(a)	enzymes	(i)	polysachharide
(b)	cellulose	(ii)	hexose
(c)	ribose	(iii)	lipid
(d)	glucose	(iv)	proteins
		(v)	pentose

16.46

	LIST A		LIST B
	Property		*Corresponding compound*
(a)	biological catalyst	(i)	enzyme
(b)	long polymers with nucleotides as monomeric units	(ii)	lipids
(c)	waxy or oily substances present in all living organisms	(iii)	nucleic acid
(d)	esters of long chain fatty acids and long chain monohydric alcohols	(iv)	proteins
		(v)	waxes

II. SHORT-ANSWER TYPE ITEMS

16.47 What are 'anomers'?

16.48 What is the difference between amylose and amylopectin?

16.49 What are carbohydrates? What are their main functions?

16.50 What is meant by mRNA?

16.51 What is 'mutation'?

16.52 Why do phospholipids have good emulsifying and membrane forming properties?

16.53 How does the secondary structure of protein arise?

16.54 How do the enzymes function?

16.55 What is a peptide bond? Give an illustration.

16.56 What are gums and pectins, write a few uses of each

16.57 Distinguish between oils and fats.

16.58 Name any two diseases caused in humans due to enzyme deficiency. State their remedy

16.59 What is the composition of phosphoglycerides?

III LONG-ANSWER TYPE ITEMS

16.60 'Living beings are like factories'. Expand this statement.

16.61 (a) What are carbohydrates?

(b) What are monosaccharides, disaccharides and polysaccharides? What are their characteristics? Give examples of each class.

16.62 (a) What is the general formula of an amino acid?

(b) How many commonly occurring amino acids are there? What are essential amino acids?

(c) What is meant by primary structure, secondary structure and tertiary structure of proteins?

(d) What are the basic functions of proteins?

(e) What is meant by denaturation of proteins?

16.63 How are cellulose and cellulose products useful to us?

16.64 (a) Explain the characteristic features of enzymes

(b) How do enzymes work?

16.65 Explain the various steps involved in replication and protein synthesis by nucleic acids

16.66 Explain the terms :

(a) mRNA

(b) tRNA

(c) codon

(d) genetic code

16.67 Briefly explain the structure of DNA.

16.68 (a) What are lipids? Which are the most abundant lipids?

(b) What do phosphoglycerides contain?

(c) Explain the role of phospholipids in the formation of cell membranes.

UNIT 17

Chemistry of Some Biological Processes

I. OBJECTIVE TYPE ITEMS

(A) **Multiple Choice**

Write the correct answer

17.1 Anabolism is the process of ·
- (a) degradation of macromolecules by cells
- (b) synthesis of various molecules of cells
- (c) uptaking of nutrients from the environment
- (d) loosing water by cells

17.2 Catabolism is the process of ·
- (a) synthesis of complex biomolecules, from simple ones with liberation of energy
- (b) degradation of complex biomolecule, with absorption of energy
- (c) degradation and synthesis of biomolecules
- (d) degradation of the complex biomolecules into smaller ones and into carbondioxide and water with the liberation of energy

17.3 The process of synthesis and degradation of biomolecules in cells together, is known as ·
- (a) anabolism
- (b) catabolism
- (c) metabolism
- (d) None of the above

17 4 The energy associated with adenosine triphosphate molecule is stored in :
- (a) C – C bonds
- (b) C – N bonds
- (c) C – O bonds
- (d) O – P bonds

17.5 The process of conversion of solar energy into chemical energy in living systems is termed as :
- (a) photoreaction
- (b) photoelectricity
- (c) photosynthesis
- (d) phototropism

17.6 The energy from adenosine triphosphate is released by the process of
- (a) hydrolysis
- (b) dehydration
- (c) oxidative cleavage
- (d) reduction.

17.7 The metal present in chlrophyll is .
- (a) calcium
- (b) magnesium
- (c) iron
- (d) potassium.

17.8 Which, amongst the following, is a chemotroph?
- (a) plants
- (b) humans
- (c) algae
- (d) halobacteria

17.9 Glycolysis involves :
- (a) production of ATP by anaerobic cells
- (b) joining of acetyl coenzyme by oxaloacetate to form citrates
- (c) a series of oxidation reduction reaction producing most of the ATP
- (d) aerobic oxidation of glucose.

17.10 The digestive enzyme present in the saliva is .
- (a) amylase
- (b) pepsin
- (c) cellulose
- (d) trypsin

17.11 The enzymatic hydrolysis of starch produces
- (a) lactose
- (b) maltose
- (c) sucrose
- (d) ribose.

17.12 The enzyme that breaks large protein molecules to small peptides is :
- (a) peptidases
- (b) pepsin
- (c) trysin
- (d) proteases

17.13 Most of the ATP formed in the oxidation of glucose is during .
(a) glycolysis
(b) the citric acid cycle
(c) cellular respiration
(d) the electron transport chain process.

17 14 Blood solution devoid of particles is called ·
(a) erythrocytes
(b) blood serum
(c) blood plasma
(d) leukocyte

17 15 The presence of a bacterium, virus or foreign protein triggers the production of specialised protein molecules known as antibodies or
(a) myoglobin
(b) lymphocyte
(c) immunoglobulin
(d) antigen.

17 16 Hormones are chemical molecules which ·
(a) act as messengers for the body
(b) block production of histamines
(c) trigger production of antibodies
(d) serve to store oxygen in the muscle tissues

17 17 The main function of haemoglobin present in red blood cells is .
(a) to act as a defence against infections
(b) to prevent blood clotting
(c) transportation of electrolytes in the body
(d) to carry inhaled oxygen from lungs to tissues.

17 18 The composition of blood plasma is :
(a) blood - (RBC + WBC)
(b) blood - RBC
(c) blood - blood platelets
(d) blood - (RBC + WBC + blood platelets).

17.19 The composition of blood serum is :
(a) blood plasma - fibrinogen
(b) blood - (RBC + WBC + blood platelets)
(c) blood - fibrinogen
(d) blood - blood plasma.

17 20 The metal present in haemoglobin is :
(a) Mg
(b) Ca
(c) Fe
(d) Na

17.21 The number of polypeptide chains associated with haemoglobin is :
- (a) 2
- (b) 4
- (c) 6
- (d) 8

17 22 When an antigen enters blood it binds to the :
- (a) RBC-s
- (b) plasma
- (c) blood platelets
- (d) lymphocytes

17.23 The hormone secreted by the posterior lobe of the pituitary gland is :
- (a) vasopressin
- (b) progesterone
- (c) adrenaline
- (d) cortisone.

17.24 Steroid, the excess of which results in high blood pressure is .
- (a) dihydrotestosterone
- (b) androgens
- (c) corticosterone
- (d) testosterone.

17.25 The hormone needed to prepare humans for emergency is ,
- (a) testosterone
- (b) adrenaline
- (c) oxytosin
- (d) vasopressin

17.26 Use of hormone banned from competitive sports is :
- (a) anabolic steroid
- (b) peptide hormone
- (c) adrenaline
- (d) thyroid hormone.

17.27 Hormone which is a water soluble amine compound is
- (a) adrenaline
- (b) testosterone
- (c) estrogen
- (d) oxytosin.

17 28 Blindness is caused by the deficiency of vitamin :
- (a) A
- (b) B-complex
- (c) C
- (d) D

17.29 Pernicious anaemia can result due to the deficiency of vitamin :
- (a) A
- (b) B_{12}
- (c) C
- (d) D

17.30 The deficiency of vitamin D leads to
- (a) night blindness
- (b) anaemia
- (c) beri-beri
- (d) rickets

17.31 Of the following groups, which group has all fat soluble vitamins?
- (a) A, B-complex, C, D
- (b) A, D, E, K
- (c) K, B complex, A, E
- (d) C, A, E, D

(B) Completion Type

Complete the following :

17.32 Series of reactions in which complex organic molecules are degraded into smaller ones and into carbondioxide and water with liberation of energy is referred to as _________

17.33 ATP stands for the energy rich compound ___________.

17.34 The process of conversion of solar energy into chemical energy is called __________

17.35 Enzymes amylases are inactive when the pH of the medium is_____(i)____

17.36 In the small intestine, food gets mixed with __________, which emulsifies fats

17.37 Glycolysis occurs in _________ of cells and does not require oxygen

17.38 The energy released during catabolism of glucose is used for the synthesis of ___________ and for maintaining body temperature.

17.39 Enzymes of protein digestion are called_____(i)_____, and_____(ii)_____.

17.40 The second stage of glucose oxidation is _________.

17.41 Vitamin C is also known as _________

17.42 The water soluble vitamins are______(i)______, and fat soluble vitamins are _____(ii)_____.

17.43 Carrot is a good source of vitamin _________.

17.44 The deficiency of vitamin A causes blindness and _________

17.45 Deficiency of vitamin C leads to the disease named _________

17.46 In petrochemicals, micro-organisms designed for growth on oil and hydrocarbons can also act as environmental __________.

(C) True or False Type

Classify the following statements as true (T) or false (F) :

17.47 Grazing animals have proper digestive enzymes for digesting cellulose

17.48 Enzymes amylases become inactive in acidic medium.

17.49 In cells, 38 molecules of ATP are generated from 1 molecule of glucose, though the net production of ATP per molecule of glucose is 36.

17.50 Theoretically oxidation of 1 molecule of glucose affords 100 ATP molecules

17.51 The efficiency of energy conversion in oxidation of glucose is 100%

17.52 The fatty acids are oxidised in mitochondria of liver cells and skeletal muscles

17.53 Similar to carbohydrates and lipids, amino acids can also be stored.

17.54 The control of water balance in the body is performed mainly by the kidneys

17.55 The communication among cells is mediated by certain chemical molecule called antibodies.

17.56 All vitamins are water soluble.

17.57 Red blood cells are called leukocytes and the white blood cells are called erythrocytes

17.58 It is conjectured that simple organic molecules originated from inorganic molecules

(D) Matching Type

Match the items in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B.

17.59

	LIST A		LIST B
	Property		*Characterised by*
(a)	anabolism	(i)	those which get chemical energy by consuming organic molecules produced by phototrophs
(b)	chemotrophs	(ii)	those which live without oxygen
(c)	anaerobic cells	(iii)	chemical molecules which mediate comunication between cells
(d)	antihistamines	(iv)	a set of chemical reactions by which synthesis of various molecules of cells are achieved
		(v)	drugs used to combat the effects of allergy

17.60

LIST A	LIST B
Hormone/Enzymes	*Activity*
(a) anabolic steroid	(i) increases muscle mass and strength
(b) adrenalin	(ii) compounds whose structure is based on a four-ring network consisting of 3 cyclohexane rings and 1 cyclopentane ring
(c) steroids	(iii) converts peptides into amino acids
(d) protease	(iv) prepares humans for emergency
	(v) breaks large protein molecules to smaller peptides

II SHORT-ANSWER TYPE ITEMS

17.61 Why is ATP an energy rich molecule?

17.62 Name the pigment responsible for photosynthesis What metal does it contain?

17.63 Why are humans unable to digest cellulose? Can grazing animals digest cellulose?

17.64 How is oxygen transported in various parts of the human system?

17.65 How are antibodies produced in our body?

17.66 What is meant by allergy? What are 'mast cells'?

17.67 Based on their chemical structure, what are the three classes of hormones? Give an example each of a nano-peptide and an octapeptide hormone.

17.68 What are the functions of steroid hormones in the human body?

17.69 Give one application of each of the following vitamins
(i) Vitamin A (ii) Vitamin B-complex group
(iii) Vitamin C (iv) Vitamin D
(v) Vitamin K

17.70 Which vitamin is produced in the human body on exposure to sunlight?

17.71 Give three applications of genetic engineering to society.

17.72 Explain the term 'genetic code'. How does it help in information processing?

III LONG-ANSWER TYPE ITEMS

17.73 (a) What is adenosine triphosphate?
(b) How do cells derive all their need of ATP?
(c) What is anabolism and catabolism?
(d) Are all chemical reactions within cells anabolic or are they all catabolic?
(e) Stepwise degradation of sugar to CO_2 and H_2O is a reaction with ΔG negative. How then does this reaction proceed in a cell? Explain.

17.74 What is the composition of blood? What is its primary function in the body?

17.75 What are the various biochemical transformations that take place during digestion of food?

17.76 What are hormones? What are the different types of hormones? Name three hormones along with their use.

17.77 Why is water called the 'ideal physiological fluid'?

17 78 What is the current view about chemical evolution and origin of life?

UNIT 18

Chemistry in Action

I OBJECTIVE TYPE ITEMS

(A) Multiple Choice

Write the correct answer :

18.1 The colour of naturally occurring indigo dye is :
- (a) red
- (b) green
- (c) blue
- (d) orange.

18.2 The colour of alizarin dye obtained from plants is :
- (a) blue
- (b) yellow
- (c) red
- (d) black.

18.3 Acid dyes are usually :
- (a) salts of sulphonic acids
- (b) diazonium salts
- (c) compounds containing amino groups
- (d) azo dyes

18.4 Malachite green is a :
- (a) direct dye
- (b) acid dye
- (c) vat dye
- (d) basic dye.

18.5 Of the following a basic dye is :
- (a) aniline yellow
- (b) phthalein dye
- (c) alizarin
- (d) orange-I.

18.6 Congo red is a :
- (a) disperse dye
- (b) direct dye
- (c) azo dye
- (d) vat dye

18.7 Of the following a direct dye is :
- (a) malachite green
- (b) orange-I
- (c) indigo
- (d) martius yellow.

18 8 The dye that is used for dyeing polyacrylonitrile is a :
- (a) direct dye
- (b) disperse dye
- (c) mordant dye
- (d) azo dye

18 9 The function of an analgesic is to :
- (a) relieve pain
- (b) kill bacteria
- (c) increase blood pressure
- (d) prevent depression and hypertension.

18.10 The plant Rauwolfia serpentina is used in Ayurveda to treat :
- (a) high blood pressure
- (b) pain
- (c) low blood pressure
- (d) malaria

18 11 The bark of the willow tree contains a compound which can :
- (a) reduce high blood pressure
- (b) act as an antibiotic
- (c) act as an analgesic
- (d) increase low blood pressure.

18.12 Derivatives of barbituric acid are used as :
- (a) analgesics
- (b) antibiotics
- (c) tranquilizers
- (d) antipyretics

18.13 Tranquilizers are mainly used for the treatment of .
- (a) mental diseases
- (b) malaria
- (c) pain
- (d) low blood pressure.

18.14 The first antibiotic discovered was :
- (a) streptomycin
- (b) penicillin
- (c) tetracycline
- (d) chloramphenicol.

18.15 To impart antiseptic properties to soap, the chemical added is :
- (a) bithional
- (b) iodine
- (c) chlorine
- (d) sulphur dioxide.

18.16 Amoxicillin is semi-synthetic modification of :
- (a) penicillin
- (b) streptomycin
- (c) tetracycline
- (d) chloramphenicol.

18.17 Dettol is the mixture of :
- (a) chloro-xylenol and terpeneol
- (b) bithional and terpeneol
- (c) barbituric acid and luminal
- (d) salicylic acid and luminal.

18.18 Saturn booster rocket used in the American space programme derives its thrust for the initial stage from a combination of :
- (a) liquid oxygen and liquid hydrogen
- (b) polyurathane and polybutadiene
- (c) kerosene and liquid oxygen .
- (d) hydrazine and nitrogen tetroxide.

18.19 In a composite propellent the oxidizer is :
- (a) polyurethane
- (b) polybutadiene
- (c) ammonium perchlorate
- (d) finely divided aluminium or magnesium

18.20 As propellant the Indian SLV-3 and ASLV rockets use :
- (a) composite solid propellants
- (b) double base propellants
- (c) biliquid propellants
- (d) monopropellants

(B) Completion Type

Complete the following :

18.21 (i) Alizarin dye gives rose red colour with ________.

(ii) Alizarin dye with barium gives ________ colour.

(iii) Orange-I is prepared by coupling of __(a)__ with __(b)__

(iv) Basic dyes contain __(a)__ groups which in __(b)__ solution form water soluble cations

(v) Direct dyes are most useful for fabrics which can form ________.

18.22 (i) Aspirin is the common name for the compound ________

(ii) Rauwolfia serpentina is used in Ayurveda to treat ________.

(iii) Substances which bring down body temperature in high fever are called ________.

(iv) Analgesics are used for ________.

(v) Tincture of iodine is a solution containing 2-3% iodine in ________ solution

18.23 (i) For preservation, squashes are sterilized by using low concentration of ________.

(ii) Derivatives of barbituric acid are known for their ________ property

(iii) The first antibiotic discovered was ________.

(iv) Aspirin generates __(i)__, due to which if the drug is taken in empty stomach it causes __(ii)__

(v) In India penicillin is manufactured at __(i)__ and __(ii)__

18.24 (i) A propellent is a combination of __(a)__ and __(ii)__

(ii) Double base propellant consists of nitroglycerine and ________

(iii) UDMH stands for the liquid propellant consisting of __(a)__ and MMH stands for the liquid propellant __(b)__.

(iv) As propellant Indian SLV and ASLV rockets use ________.

(v) Liquid propellants which are single chemical compounds but on decomposition or ignition give out hot gases are called ________

(C) True or False Type

Classify the following statements as true (T) or false (F).

18.25 Orange-I is an example of an acid dye.

18.26 Basic dyes are nitro dyes.

18.27 Direct dyes are most useful for those fabrics which can form hydrogen bonds

18.28 Disperse dyes are used for polyesters, nylon.

18.29 Mordant dyes are applied to the fabric after treating it with a metal ion

18.30 At all concentration, disinfectants can also act as antiseptics.

18.31 Concentration of chlorine used for making water fit for drinking varies from 0.2 to 0.4 ppm

18.32 Iodoform was used as an antiseptic wound powder.

18.33 Equanil (a tranquilizer) is used for the treatment of depression and hypertension.

18.34 The first antibiotic was discovered by Alexander Flemming

18.35 Oxidizer used in the Titan ballistic missile is nitrogen tetroxide.

18.36 India's first successful satellite launch vehicle is the ASLV.

18.37 The most common and widely used solid propellant is called the monopropellant

(D) Matching Type

Match the item given in List A with relevant answers given in List B by indicating the serial number of the item of List A against that of List B.

18.38

	LIST A		LIST B
	Propellant type		*Example*
(a)	monopropellant	(i)	liquid oxygen + alcohol
(b)	solid propellant	(ii)	nitroglycerine + nitrocellulose
(c)	double base propellant	(iii)	hydrazine
		(iv)	polybutadiene + ammonium perchlorate + magnesium

18.39

	LIST A		LIST B
	Use		*Corresponding drug*
(a)	eradication of malaria	(i)	morphine
(b)	lowering of high blood pressure	(ii)	0.2% solution of phenol
(c)	reducing body temperature in high fever	(iii)	paracetamol
		(iv)	Rauwolfia serpentina
(d)	killing microorgansim—applied to inanimate objects	(v)	1% solution of phenol
		(vi)	chloroquin

18.40

	LIST A		LIST B
	Characteristics		*Corresponding dye*
(a)	dying is fast and colour is retained for a long time	(i)	congo red
(b)	direct dye	(ii)	orange-1
(c)	contains amino group which in acid solution forms water soluble cations	(iii)	fibre reactive dye

(d)	prepared by coupling diazotised 4-Aminobenzene sulphanilic acid with α naphthol	(iv)	basic dyes
		(v)	indigo

II SHORT-ANSWER TYPE ITEMS

18.41 Are all dyes synthetic? If not, give examples of natural dyes.

18.42 How do dyes impart colour to a fabric?

18.43 Which were the possible earliest known natural dyes?

18.44 Give an example of basic dye.

18.45 What is a mordant dye?

18.46 How are dyes classified?

18.47 What is meant by the term 'chemotherapy'?

18.48 What is the function of aspirin?

18.49 What are antipyretics?

18.50 Why is paracetamol taken?

18.51 What is an antiseptic? Give an example.

18.52 Give an example of a tranquilizer and state why it is taken.

18.53 What is an antibiotic? Which was the first antibiotic discovered?

18.54 What is chloramphenicol? What is its use?

18.55 How many natural penicillins are isolated so far? Name two semisynthetic modification of penicillin.

18.56 How does iodine act as an antiseptic?

18.57 What is a propellant?

18.58 What are the different types of rocket propellants known?

18.59 Give an example of a widely used solid propellant.

18.60 What sort of propellant will the PSLV-rocket use?

18.61 What is a hybrid rocket propellant? Give an example.

III. LONG-ANSWER TYPE ITEMS

18.62 How are dyes classified based on their application? Give an example of each, and wherever possible write where it is used.

18.63 Antibiotic therapy is a case of "setting one thief against another". Explain this statement

18.64 (a) What are antiseptics? Give examples

(b) What are disinfectants? Give examples.

(c) Can the same substance be used as an antiseptic as well as a disinfectant? Give an example.

(d) Are organic dyes used as antiseptics? Give an example.

18 65 (a) What are tranquilizers? Give examples.

(b) It is said that tranquilizers do not add anything to the individuals that is already not present Then how do tranquilizers act?

18.66 (a) What is a propellant?

(b) Very briefly discuss how does a rocket gets its thrust.

(c) What are the three basic classification of propellants? Give examples of each type

(d) What propellants are used in the following rockets?

(a) Saturn booster (b) Titan ballistic missile

(c) SLV-3 and ASLV (d) PSLV-rocket

KEY

UNIT 1

Item		*Key*	*Abilities*
1.1		(d)	k
1.2		(d)	k
1.3		(a)	k
1.4		(a)	u
1.5		(d)	u
1.6		(d)	u
1.7		(c)	k
1.8		(d)	k
1.9		(c)	k
1.10		(d)	k
1.11		(c)	k
1.12		(a)	k
1.13		(c)	k
1.14		(a)	u
1.15		(b)	u
1.16		(b)	an
1.17		(d)	k
1.18		(b)	an
1.19		simultaneously	k
1.20		greater	u
1.21		$\lambda=\frac{h}{mv}$	k
1.22	(i)	2	k
	(ii)	$\pm 2, \pm, 1, 0$	k
1.23		wave function	k
1.24		four	k
1.25	(i)	1, 2, 3, .. upto ∞	k
	(ii)	0, 1, 2, .(n-1)	
	(iii)	$-\ell, (-\ell+1),...0...(\ell-1), \ell$	
1.25	(iv)	$+\frac{1}{2}$ or $-\frac{1}{2}$	

Item		*Key*	*Abilities*
1.26		density	k
1 27		positive	k
1.28		$\frac{1}{2}$	an
1.29		pi	k
1 30		symmetrical	k
1.31		sp^2	u
1.32		octahedron	k
1 33		90°	k
1 34		ns^2np^6	k
1.35	(i)	parallel	k
	(ii)	Hund's rule	k
1 36	(i)	two	k
	(ii)	π 2p	
	(iii)	π^* 2p	
1.37	(i)	3s,	k
	(ii)	3p	
	(iii)	3d	
1.38		equal to	u
1 39		maximum	k
1 40		T	k
1 41		F	k
1 42		F	u
1.43		F	k
1.44		F	u
1 45		F	u
1.46		F	k
1.47		T	k
1 48		F	u
1.49		F	k
1.50		T	k
1.51		F	u
1.52		T	u
1 53		T	k
1.54		F	u
1.55		T	k
1.56		T	ap
1 57		F	k
1 58		T	k
1.59		T	k
1.60	(a)	(iii)	k
	(b)	(i)	k

Item		*Key*	*Abilities*
	(c)	(ii)	k
1.61	(a)	(iii)	u
	(b)	(v)	u
	(c)	(ii)	u
	(d)	(iv)	u
1.62	(a)	(v)	k
	(b)	(iii)	k
	(c)	(i)	k
	(d)	(vii)	k
	(e)	(ii)	k
	(f)	(vi)	k
1.63	(a)	(v)	u
	(b)	(i)	u
	(c)	(ii)	u
	(d)	(iii)	u
1.64			ap
1.65			u
1.66			u
1.67			an
1.68			k
1.69			k
1.70			an
1.71			ap
1.72			ap
1.73			an
1.74			u
1.75			an
1.76			u
1.77			k
1.78			an
1.79			an
1.80			u
1.81			an
1.82			k
1.83		6.6×10^{-29} m	
1.84		5.3×10^{25} kg m s^{-1}	
1.85		2.4×10^{-3} m	
1.86	(a)	$+ 1.82 \times 10^{5}$ J mol^{-1}	
	(b)	29×10^{14} s^{-1}	
	(c)	103 nm	
1.87		230.2 nm	
1.88	(a)	18 nm	
1.89	(b)	2.2×10^{19} nm	

UNIT 2

Item		*Key*	*Abilities*
2.1		(c)	ap
2.2		(a)	ap
2.3		(a)	k
2.4		(c)	k
2.5		(a)	k
2.6		(c)	k
2.7		(d)	k
2.8		(a)	k
2.9		(d)	u
2.10		(a)	k
2.11		(d)	k
2.12		(a)	k
2.13		(a)	k
2.14		(c)	k
2.15		(d)	k
2.16		(b)	k
2.17		(d)	k
2.18		(a)	k
2.19		(d)	k
2.20		(c)	k
2.21		$\frac{1}{8}$ th	ap
2.22		1	u
2.23		SiO_4	k
2.24	(i)	silicon	k
	(ii)	aluminium	k
2.25		silicate	k
2.26		$(Si_2O_5)^{2-}$	k
2.27		four	k
2.28		x^3cm^3	u
2.29		lowers	k
2.30		Frenkel	k
2.31		F	k
2.32		violet	k
2.33		holes	k
2.34		semiconductors	k
2.35		diamagnetic	k
2.36		paramagnetic	k
2.37		dipoles	k

Item		*Key*	*Abilities*
2.38		diamagnetic	k
2.39	(i)	Fe	k
	(ii)	Co	k
	(iii)	Ni	k
	(iv)		
2.40		electrical conductivity	k
2.41		anti-ferromagnetism	k
2.42	(i)	metals	k
	(ii)	insulators	
	(iii)	semiconductors	
2.43	(i)	increases	k
	(ii)	decreases	k
2.44		F	k
2.45		F	k
2.46		T	k
2.47		T	k
2.48		F	k
2.49		F	k
2.50		T	k
2.51		T	k
2.52		F	k
2.53		F	u
2.54		F	u
2.55		F	k
2.56	(i)	(c)	k
	(ii)	(d)	k
	(iii)	(b)	k
	(iv)	(e)	k
2.57	(i)	(e)	k
	(ii)	(a)	k
	(iii)	(c)	k
	(iv)	(b)	k
2.58	(i)	(e)	k
	(ii)	(c)	k
	(iii)	(a)	k
	(iv)	(b)	k
2.59			ap
2.60			an
2.61			u
2.62			k
2.63			k
2.64			an

Item		***Key***	***Abilities***
2.65			u
2.66			k
2.67			k
2.68			k
2.69			k
2.70			u
2.71			k
2.72			k
2.73			k
2.74			k
2.75			k
2.76			ap
2.77			an
2.78			u
2.79			k
2.80			k
2.81			k
2.82			k
2.83			k
2.84			
2.85			
2.86	(i)	1	
	(ii)	2	
	(iii)	4	
2 87		7 07m^3	
2.88		10 6g/cm^3	
2.89		14.53 nm	
2.90		74%	
2.91	(i)	152.9 pm	
2.92	(ii)	68%	
2 93		6.03 x 10^{23} mol^{-1}	
2 94		74.7 g mol^{-1} A_3B_2	

UNIT 3

3.1	(a)	k
3.2	(a)	k

Item	*Key*	*Ability*
3.3	(b)	u
3 4	(b)	k
3.5	(a)	u
3.6	(c)	k
3.7	(b)	u
3.8	(c)	ap
3.9	(c)	k
3 10	(a)	k
3.11	(a)	k
3 12	(a)	u
3.13	(b)	u
3.14	(c)	k
3 15	(a)	u
3.16	(a)	k
3.17	(b)	u
3.18	(a)	ap
3 19	(d)	u
3.20	(c)	k
3.21	number of moles of a particular component in the solution to total number of moles of all components in the solution	k
3.22	molality	k
3 23	solution	k
3 24	solution	u
3 25 (i)	non-polar	k
(ii)	polar	
3.26	equilibrium vapour pressure	k
3.27	relative lowering of vapour pressure	k
3.28	lowered	k
3.29	mole fraction	k
3.30	solvent	k
3.31	vapour pressure of the pure component	u
3.32	(i) the partial vapour pressure of the components	k
	(ii) Dalton's	k
3.33	higher	u
3 34	different	u
3 35	more volatile	u
3.36	number of particles (molecules or ions)	k
3 37	half (lower)	k
3.38	weaker	k

Item		*Key*	*Ability*
3.39	(i)	decreases	u
	(ii)	decreases	u
3.40		atmospheric pressure	k
3.41		raised	k
3.42		molal boiling point elevation constant	k
3.43	(i)	raised	u
	(ii)	lowered	
3.44		Raoult's	k
3.45		decreases	u
3.46	(i)	solution	k
	(ii)	solvent molecules	
3.47		K kg mol^{-1}	k
3.48	(i)	solvent	u
	(ii)	semipermeable	
3.49		two	
3.50		dissociate	u
3.51		$\frac{\text{normal molecular mass}}{\text{observed molecular mass}}$	
3.52	(i)	less	
	(ii)	greater	k
3.53	(i)	associated	k
	(ii)	dissociated	k
3.54		boiling	k
3.55	(i)	F	k
	(ii)	T	k
	(iii)	F	k
	(iv)	F	k
	(v)	T	k
3.56	(i)	T	k
	(ii)	T	u
	(iii)	T	u
	(iv)	F	k
	(v)	T	k
3.57	(i)	T	k
	(ii)	T	u
	(iii)	F	u
	(iv)	F	k
	(v)	T	u
3.58	(i)	T	u
	(ii)	T	k

Item		*Key*	*Ability*
3.58	(iii)	T	k
	(iv)	F	k
	(v)	T	k
3.59	(i)	F	u
	(ii)	T	k
	(iii)	F	u
	(iv)	T	u
	(v)	F	k
3.60	(i)	F	u
	(ii)	T	u
	(iii)	F	u
	(iv)	F	u
	(v)	T	u
3.61	(i)	(a)	
	(ii)	(b)	
	(iii)	(f)	
	(iv)	(e)	
	(v)	(d)	
3.62			k
3.63			k
3.64			k
3.65			u
3.66			k
3.67			k
3.68			k
3.69			k
3.70			k
3.71			k
3.72			u
3.73			k
3.74			k
3.75			ap
3.76			k
3.77			k
3.78			u
3.79			u
3.80			k
3.81			k
3.82			k
3.83			k
3.84			k

Item		*Key*	*Ability*
3.85			k
3.86			k
3.87			ap
3.88			k
3.89			an
3.90			k
3.91			k
3.92	(i)	0.56 mol kg^{-1}	
	(ii)	01	
3.93		$50 cm^3$	
3.94	(i)	mass per cent of water 92.0% mass percentage of ethanoic acid 8.0%	
	(ii)	mole fraction of ethanoic acid 0.025 mole fraction of water 0.97	
	(iii)	molality of ethanoic acid 1.45 mol kg^{-1}	
	(iv)	partial vapour pressure of ethanoic acid 2.5 mm of Hg	
	(v)	partial vapour pressure of water = 122.5 mm	
	(vi)	vapour pressure of pure water = 126.29 mm	
3.95		$P^\circ_B = 200$ mm $P^\circ_A = 500$ mm	
3.96		3.87×10^2 mm Hg	
3.97		1.25×10^5	
3.98		45.45 g mol^{-1}	
3.99		91.5 g mol^{-1}	
3.100		373.26 K	
3.101		1.8	
3.102		373.64 K	
3.103		At freezing point benzoic acid exists as a dimer.	

UNIT 4

4.1	(d)	u
4.2	(a)	u
4.3	(d)	u
4.4	(b)	u
4.5	(c)	u
4.6	(c)	u

Item		*Key*	*Ability*
4.7		(c)	ap
4.8		(b)	k
4.9		(d)	u
4.10		(d)	u
4.11		(c)	ap
4.12		(b)	u
4.13		(d)	ap
4.14		(d)	ap
4.15		(b)	u
4.16		(c)	u
4.17		(a)	u
4.18		(b)	u
4.19		(c)	k
4.20		(d)	k
4.21		positive	k
4.22	(i)	heat absorbed	k
	(ii)	volume	k
4.23		greater	k
4.24		isolated	k
4.25		size	k
4.26		gases	k
4.27		average	k
4.28		298 K	k
4.29		4	u
4.30		+ 113.63 J mol^{-1}	ap
4.31		T	k
4.32		T	u
4.33		F	u
4.34		T	k
4.35		F	k
4.36		T	k
4.37		F	k
4.38		F	k
4.39	(a)	(iii)	k
	(b)	(i)	k
	(c)	(vii)	k
	(d)	(ii)	k
	(e)	(iv)	k
4.40			u
4.41			k

Item	*Key*	*Ability*
4.42		an
4.43		ap
4.44		ap
4.45		ap
4.46		u
4.47		k
4.48		k
4.49		k
4.50		k
4.51		k
4.52		k
4.53		k
4.54		k
4.55		k
4.56		u
4.57		k
4.58		u
4.59		k
4.60		u
4.61		u
4.62		an
4.63	$- 2317.48\ \text{kJ mol}^{-1}$	
4.64	293K	
4.65	$+59.9\ \text{kJ mol}^{-1}$	
4.66	$+ 462.8\ \text{kJ mol}^{-1}$	
4.67	$+ 3891\ \text{kJ mol}^{-1}$	
4.68	$+ 21.98\ \text{J mol}^{-1}\ \text{K}^{-1}$	
4.69	$- 229\ \text{kJ mol}^{-1}$	
4.70	$+ 55.8\ \text{kJ mol}^{-1}$, reaction not spontaneous	
4.71	$- 163.4\ \text{JK}^{-1}\ \text{mol}^{-1}$	
4.72	0.3447	

UNIT 5

5.1	(d)	k
5.2	(c)	k
5.3	(b)	u

Item		*Key*	*Ability*
5.4		(c)	k
5.5		(d)	u
5.6		(a)	u
5.7		(a)	k
5.8		(d)	u
5.9		(b)	k
5.10		(a)	ap
5.11		(d)	k
5.12		(d)	k
5.13		(c)	ap
5.14		(d)	ap
5.15		(a)	k
5.16		fuel cells	k
5.17	(i)	solvation of ions	k
	(ii)	viscosity of the solvent	
5.18	(i)	individual ions	k
	(ii)	Kohlrausch's	
5.19		concentration of the solution in equivalents per litre	k
5.20		$\alpha_c = \frac{\lambda_m^c}{\lambda_m^\infty}$ or degree of dissociation = $\frac{\text{molar conductivity of the electrolyte at conc c}}{\text{molar conductivity of the electrolyte at infinite dilution}}$	k
5.21	(i)	lose	k
	(ii)	electrochemical series	k
5.22		an anode	k
5.23		galvanisation	k
5.24	(i)	electrical conductance	k
	(ii)	siemens or S or ohm^{-1}	
5.25		391	ap
5.26		F	u
5.27		T	k
5.28		T	k
5.29		T	u
5.30		F	k
5.31		T	u
5.32		T	k
5.33		T	k
5.34		F	k
5.35	(a)	(iii)	

Item	*Key*	*Ability*
5.35 (b)	(i)	k
(c)	(iv)	
5.36 (a)	(ii)	
(b)	(iii)	
(c)	(i)	
5.37 (a)	(ii)	
(b)	(i)	k
(c)	(iv)	
5.38		k
5.39		k
5.40		k
5.41		k
5.42		k
5.43		u
5.44		u
5.45		k
5.46		k
5.47		u
5.48		k
5.49		ap
5.50		ap
5.51		an
5.52		an
5.53		k
5.54		k
5.55		k
5.56		k
5.57		an
5.58		ap
5.59		an
5.60	0.422 ampere	
5.61	22797.6 cm^{-1}	
5.62	271.7 S cm^2 mol^{1}	
5.63 (a)	0.042	
(b)	1.83 x 10^{5}	
5.64	- 0.76 V	
5.65	3.2 V	
5.66	0.40 V	
5.67	- 0.81 V	
5.68	9.20 x 10^{5} mol	
5.69	4.4 x 10^{4} or 12.33 h	

Item		*Key*	*Ability*
5.70		$-202\ 7$ kJ mol^{-1}	
5 71		6 5 cm	
5.72	(a)	anode. $\frac{1}{2}H_2(g)+(OH^-)(aq) \rightarrow H_2O(l)+-\bar{e}$	
		cathode $H^+(aq)+\bar{e} \rightarrow \frac{1}{2}H_2$	
	(b)	$H^+(aq)+\overline{OH}(aq) \rightarrow H_2O(l)$	
	(c)	1×10^{14}	
5 73	(a)	.0443	
	(b)	4 43%	

UNIT 6

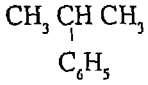
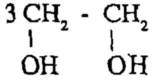
6 1		(c)	k
6.2		(d)	u
6.3		(a)	u
6.4		(d)	k
6 5		(a)	k
6.6		(c)	k
6 7		(b)	ap
6.8		(d)	an
6.9		(c)	u
6 10		(a)	ap
6.11		(b)	ap
6.12		(a)	ap
6 13	(i)	(a)	ap
	(ii)	(b)	
	(iii)	(c)	
6 14	(i)	(b)	
	(ii)	(c)	
	(iii)	(c)	
	(iv)	(b)	
	(v)	(b)	
6.15	(i)	(b)	ap
	(ii)	(a)	
	(iii)	(c)	
	(iv)	(d)	

Item		*Key*	*Ability*
6.16	(i)	$-\frac{1}{2}\frac{d[O_3]}{dt}$	u
	(ii)	$\frac{1}{3}\frac{d[O_2]}{dt}$	u
6.17		average	k
6.18		3	u
6.19		1	u
6.20		s^{-1}, mol $L^{-1}s^{-1}$	u
6.21		ln2 or 0.693	k
6.22		remains constant	u
6.23		$e^{-Ea/RT}$	k
6.24		photosensitisation	k
6.25		less	k
6.26		NO_2	an
6.27		one	k
6.28		rate constant	k
6.29		F	k
6.30		F	k
6.31		T	k
6.32		T	k
6.33		F	k
6.34		F	k
6.35		F	u
6.36		T	k
6.37		F	u
6.38	(a)	(iii)	k
	(b)	(v)	k
	(c)	(iv)	k
	(d)	(i)	k
6.39	(a)	(iii)	k
	(b)	(i)	k
	(c)	(ii)	k
6.40			u
6.41			k
6.42			u
6.43			u
6.44			ap
6.45			k
6.46			u

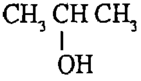
Item		*Key*	*Ability*
6.47			k
6.48			k
6.49			k
6.50			u
6.51			u
6.52			k
6.53			u
6.54			k
6.55			k
6.56			k
6.57			k
6.58			u
6.59			u
6.60			u
6.61			k
6.62	(i)	first order	k
	(ii)	1.60×10^{-2} min^{-1}	
6.63		1.50×10^{5} J mol^{-1}	
6.64		proved	
6.65	(i)	$E_a = 103.4$ kJ mol^{-1}	
	(ii)	$A = 1.82 \times 10^{13}$ s^{-1}	
	(iii)	$k_{318} = 2.37 \times 10^{-4}$ s^{-1}	
6.66		2303 s^{-1}	
6.67		proved	
6.68	(i)	first order	
	(ii)	$k = 1.9 \times 10^{-5}$ s^{-1}	
6.69	(a)	90 mm of Hg	
	(b)	47 mm of Hg	
	(c)	1.08×10^{-3} s^{-1}	

UNIT 7

7.1	(c)	u
7.2	(b)	u
7.3	(c)	u
7.4	(a)	k
7.5	(b)	u
7.6	(a)	u

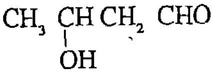
Item		***Key***	***Ability***
7.7		(d)	u
7.8		(c)	u
7.9		(d)	k
7.10		(b)	k
7.11		(a)	k
7.12		(d)	k
7.13		(d)	u
7.14		(d)	u
7.15		(b)	k
7.16		(c)	k
7.17		(a)	k
7.18		(c)	k
7.19		(c)	k
7.20		(c)	u
7.21		(d)	k
7.22		(a)	k
7.23		(d)	u
7.24		1-2-Ethanediol	u
7.25		1-Bromopropan-2ol	u
7.26		dichlorodiflouromethane	k
7.27		ozone	
7.28		gammexane or lindane	k
7.29		antiseptic	k
7.30		trichloromethane	k
7.31		glycerol	k
7.32	(i)	Kharasch effect	k
	(ii)	peroxide effect	
7.33		glyptal	k
7.34		methanol	k
7.35	(i0	$C_6H_6Cl_6$	k
	(ii)	pesticide	k
7.36		2-phenylpropane  $CH_3\,\underset{\underset{C_6H_5}{\vert}}{CH}\,CH_3$	k
7.37	(i)	$CH_3\,CH_2\,CHO$	k
	(ii)	Oxo process	k
7.38		$COCl_2$	k
7.39		$CH \equiv CH$	k
7.40		C_6H_5OH	k
7.41		 $3\,\underset{\underset{OH}{\vert}}{CH_2} - \underset{\underset{OH}{\vert}}{CH_2}$	

Item		*Key*	*Ability*
7.42	(i)	CH_3OH	u
	(ii)	NaBr	
7.43		oxonium	k
7.44		Kolbe's	k
7.45		soap	k
7.46	(i)	ethane	k
	(ii)	Wurtz reaction	k
7.47		F	k
7.48		F	u
7.49		T	u
7.50		F	u
7.51		T	k
7.52		F	k
7.53		F	k
7.54		T	k
7.55		F	u
7.56		T	k
7,57		F	u
7.58		F	u
7.59		T	k
7.60		F	u
7.61		T	k
7.62		T	k
7.63		F	u
7.64	(a)	(iv)	k
	(b)	(i)	k
	(c)	(iii)	k
	(d)	(ii)	k
7.65	(a)	(iii)	u
	(b)	(ii)	u
	(c)	(v)	u
	(d)	(i)	u
7.66	(a)	(iv)	
	(b)	(i)	
	(c)	(ii)	
	(d)	(iii)	
	(e)	(vii)	
7.67			u
7.68			u
7.69			k
7.70			an

Item		*Key*	*Ability*
7.71			k
7.72			u
7.73			k
7.74			k
7.75			k
7 76			u
7.77			k
7.78			k
7.79			u
7.80			k
7.81			k
7 82			k
7 83			an
7.84			k
7.85			ap
7.86			an
7 87			u
7 88			k
7.89			k
7.90			k
7.91			ap
7 92		A is 2-methylpropene B is propanone C is methanal D is 2-propanol	
7.93	(a)	A is $CH_3CH_2CH_2\ OH$	
	(b)	B is  $CH_3\ \underset{\underset{OH}{\mid}}{CH}\ CH_3$ C is CHI_3	
	(c)	D is $CHCl_3$ IUPAC nomenclature of D is trichloromethane	

UNIT 8

8 1	(d)	u
8.2	(c)	u
8.3	(c)	u

Item			*Key*	*Ability*
8.4			(d)	u
8.5			(d)	u
8.6			(c)	u
8.7			(d)	u
8.8			(d)	u
8.9			(c)	u
8.10			(a)	u
8.11			(d)	u
8.12			(d)	u
8.13			(c)	u
8.14			(a)	u
8.15			(d)	u
8.16			(a)	k
8.17			(c)	k
8.18			(a)	k
8.19			(c)	k
8.20			(d)	k
8.21			(c)	k
8.22			(a)	k
8.23			(c)	k
8.24			1, 2-Dimethoxyethane	u
8.25			ethanal	k
8.26			carbonyl (> C=0)	k
8.27			lower	k
8.28	(i)		alcohol	k
	(ii)		salt of carboxylic acid	
8.29			Ozonolysis	k
8.30			Reimer Tiemann reaction	k
8.31	(i)		carboxylic acids	k
	(ii)		esters	k
	(iii)		amides	k
	(iv)		anhydrides	k
	(v)		ketones	k
8.32	(a)	(i)	 $CH_3\underset{\mid}{C}H(OH)CH_2CHO$	k
		(ii)	$CH_3CH=CHCHO$	k
		(iii)	3-Hydroxybutenal	k
		(iv)	2-Butenal	k
	(b)		RCOOR'	k
	(c)		RNH_2	k
	(d)		$RC\equiv N$	

Item			*Key*	*Ability*
	(e)		CH_3 COONa	
	(f)	(i)	HSO_3 (C_6H_4) COOH	
		(ii)	3-Sulphobenzoic acid	
	(g)		CH_3COCH_3	
8.33			T	k
8.34			T	k
8 35			F	k
8.36			T	k
8.37			T	k
8 38			F	k
8.39			F	k
8.40			F	k
8.41			F	k
8 42			T	k
8 43			T	k
8 44			T	k
8.45			T	k
8.46			T	k
8 47			F	k
8 48			F	k
8.49	(a)		(v)	k
	(b)		(viii)	k
	(c)		(i)	k
	(d)		(iii)	k
	(e)		(vii)	
	(f)		(ii)	
8.50	(a)		(vi)	k
	(b)		(i)	k
	(c)		(v)	k
	(d)		(iv)	k
	(e)		(ii)	k
8.51				k
8 52				k
8.53				k
8.54				u
8.55				k
8.56				k
8 57				k
8 58				k
8.59				u
8 60				u

Key	Ability
	k
	u
	k
	k
	k
	k
	k
	k
	k
	u
	an
	an
	ap

A is Propanone
B is Propanalphenylhydrazone
C is Triiodomethane
A is Methanal
B is Methanol
C is Sodium methanoate
D is Methanoic acid

UNIT 9

(d)	u
(a)	u
(b)	u
(b)	k
(c)	k
(c)	k
(a)	k
(b)	u
(a)	k
(c)	u
(b)	k
(a)	k
(c)	k
(d)	k
(c)	k

Item			*Key*	*Ability*
9.16			secondary	k
9.17			hydrogencyanide, HCN	u
9.18			alkylnitrile	k
9.19	(i)		pleasant	k
	(ii)		disagreeable	k
9.20			ambident	k
9.21			increase	k
9.22			stronger	u
9.23			4-Aminobenzenesulphonic acid	k
9.24	(i)		alkylhalides	k
	(ii)		reduction	k
9.25			electrophilic	k
9.26	(a)		C_6H_5CN	k
	(b)		$RNHCH_3$	k
	(c)		RONO	k
	(d)	(i)	$(CH_3)_2NH_2^+\bar{Cl}$	k
		(ii)	quaternary	
	(e)		$2CH_3NH_2$	k
	(f)		ArCN	k
9.27	(a)		primary amines	k
	(b)	(i)	nitro compound	k
		(ii)	nucleophilic substitution	k
	(c)		primary	
9.28			F	k
9.29			T	k
9.30			T	k
9.31			T	u
9.32			T	k
9.33			T	k
9.34			F	u
9.35			F	u
9.36			T	k
9.37			F	k
9.38	(a)		(vi)	k
	(b)		(i)	k
	(c)		(ii)	k
	(d)		(iii)	k
	(e)		(viii)	k
9.39	(a)		(v)	k
	(b)		(ii)	k

Item		***Key***	***Ability***
9.39	(c)	(i)	k
	(d)	(vi)	k
	(e)	(iii)	k
9.40	(a)	(iii)	k
	(b)	(i)	k
	(c)	(iv)	k
	(d)	(ii)	k
9.41	(a)		u
	(b)		u
	(c)		u
9.42			u
9.43			u
9.44			u
9.45			u
9.46			k
9.47			k
9.48			k
9.49			k
9.50			k
9.51			k
9.52			k
9.53			k
9.54			k
9.55			k
9.56			k
9.57			k
9.58		A is chloroethene $CH_2 = CH\,Cl$ B : propylamine $CH_3\,CH_2\,CH_2\,NH_2$	
9.59		A is nitrobenzene $C_6H_5NO_2$ B is benzeneamine $C_6H_5\,NH_2$ C is methyl orange	
9.60		A is ethanenitrile CH_3CN B is ethanamine $CH_3CH_2NH_2$ C is complex $Cu\,[(CH_3\,CH_2\,NH_2)_4]^{2+}$	

UNIT 10

10.1		(b)	k

Item		*Key*	*Ability*
10.2		(d)	k
10.3		(b)	k
10.4		(a)	k
10.5		(b)	k
10.6		(a)	u
10.7		(c)	k
10.8		(c)	k
10.9		(c)	u
10.10		(c)	k
10.11		(b)	u
10.12		(a)	u
10.13		(a)	u
10.14		(b)	k
10.15		(a)	k
10.16		(c)	u
10.17		(a)	k
10.18		(a)	u
10.19		(d)	u
10.20		(b)	k
10.21		(d)	k
10.22		(b)	k
10.23		(a)	u
10.24		(a)	k
10.25		+ 1	k
10.26		solvated electrons	k
10.27		diagonal relationship	k
10.28		lithium	k
10.29	(i)	Li_2O	k
	(ii)	$NaNO_2$	k
10.30	(i)	less	k
	(ii)	less	k
10.31		silicon	k
10.32	(i)	four	k
	(ii)	twelve	k
10.33		linear	k
10.34		four	k
10.35		water/H_2O	u
10.36		octahedral	k
10.37		fluorine	u
10.38	(a)	$[XeF]^+[PF_6]^-$	
	(b) (i)	N_2O	

Item			*Key*	*Ability*
		(ii)	$2H_2O$	k
	(c)	(i)	N_2H_4	
		(ii)	NaCl	k
	(d)		$2Li_3N$	k
	(e)		$Si(OH)_4$	k
10.39			F	u
10.40			T	u
10.41			T	u
10.42			F	u
10 43			F	u
10.44			T	u
10.45			F	ap
10 46			T	u
10 47			F	k
10 48			T	k
10 49			T	k
10 50			F	k
10.51			F	k
10 52			T	k
10.53			T	k
10.54			F	k
10.55	(a)		(i)	
	(b)		(iii)	
	(c)		(iv)	
	(d)		(v)	
10 56	(a)		(iii)	k
	(b)		(v)	
	(c)		(ii)	
	(d)		(vi)	
10.57				u
10.58				an
10.59				u
10 60				an
10 61				u
10.62				an
10 63				u
10 64				u
10.65				k
10 66				k
10.67				u
10.68				u

Item		*Key*	*Ability*
10.69			k
10.70			an
10.71			k
10.72			an
10.73			k
10.74			k
10.75			k
10.76			k
10.77			u
10.78			u
10.79			u
10.80			k
10.81			an
10.82			an
10.83	(a)	ns^2np^3	
	(b)	AH_3	
	(c)	non-metal	
	(d)	nitrogen	
10.84	(a)	Cl_2	
	(b)	group 17	
	(c)	ns^2np^5	
	(d)	HCl and HOCl : $Cl_2 + H_2O \rightarrow HOCl + HCl$	
	(e)	$Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$	
10.85	(a)	23	
		$1s^2\,2s^2\,2p^6\,3s^1$	
	(b)	group1	
	(c)	yes	
	(d)	$2M + 2H_2O \rightarrow 2MOH + H_2$	
	(e)	yes	
	(f)	Na	

UNIT 11

11.1	(c)	u
11.2	(c)	k
11.3	(a)	k
11.4	(b)	k
11.5	(c)	k

Item			*Key*	*Ability*
11 6			(c)	u
11 7			(d)	k
11 8			(d)	k
11 9			(b)	k
11 10			(b)	k
11 11			(a)	ap
11 12			(c)	k
11 13			(d)	u
11 14			eight	k
11 15			higher	k
11 16			(i) +2	
			(ii) 4s	
			(iii) d	
			(iv) s	
11 17			(i) lanthanides	k
			(ii) actinide	k
11 18			higher	u
11 19			(i) flourides	k
			(ii) oxides	k
11 20			oxidised	k
11 21			zero	k
11 22			smaller	k
11 23			(i) completely filled	k
			(ii) empty	k
11 24			hexaquo ions	k
11.25			(i) basic	k
			(ii) acidic	k
11 26			(i) repelled	k
			(ii) attracted	k
11 27			(i) ionic	k
			(ii) covalent	k
11 28			radioactive	k
11.29	(a)		$2Cr^{3+}$	k
	(b)	(i)	$2\ HCrO_4^-$	k
		(ii)	$Cr_2O_7^{2-}$	k
	(c)		Mno_2	k
	(d)		Mn^{2+}	k
	(e)		TiO_2	k
11.30			T	k
11 31			F	u
11 32			F	k

Item		Key	Abilities
11.33		F	k
11.34		F	k
11.35		T	k
11.36		T	k
11.37		F	k
11.38		F	u
11.39		T	k
11.40		F	k
11.41		T	k
11.42		F	k
11.43		F	k
11.44		F	k
11.45		T	k
11.46	(a)	(ii)	k
	(b)	(v)	k
	(c)	(i)	k
	(d)	(iv)	k
11.47	(a)	(i)	u
	(b)	(iii)	u
	(c)	(v)	u
	(d)	(ii)	
11.48			an
11.49			an
11.50			cv
11.51			u
11.52			k
11.53			k
11.54			u
11.55			k
11.56			k
11.57			k
11.58			k
11.59			k
11.60			k
11.61			k
11.62			u
11.63			k
11.64			k
11.65			cv
11.66			ap
11.67			u

Item		*Key*	*Ability*
11.68			k
11.69			ev
11.70			ev

UNIT 12

12.1		(a)	u
12.2		(d)	u
12.3		(d)	u
12.4		(d)	u
12.5		(c)	u
12.6		(d)	u
12.7		(b)	u
12.8		(b)	u
12.9		(a)	u
12.10		(a)	u
12.11		$(Ph_3P)_3 RhCl$	k
12.12		$[PtCl_2 (NH_3)_2]$	k
12.13		chelate	k
12.14	(a)	Et_4Pb	k
	(b)	$[(C_6H_6)_2Cr]$	k
	(c)	$[Ni(CO)_4]$	k
	(d)	$[Ni (NH_3)_6]Cl_2$	k
	(e)	$[(C_2H_4) Pt Cl_3]^-$	k
12.15		hexa	k
12.16	(i)	s	k
	(ii)	p	k
	(iii)	four	k
12.17		coordination	k
12.18		octahedral	k
12.19	(i)	ionizable	k
	(ii)	nonionizable	k
12.20		chloropentamminecobalt (III) chloride	u
12.21		stability	k
12.22	(i)	hardness	k
	(ii)	stability constant	k
12.23		metal-carbon	k

Item		*Key*	*Abilities*
12.24		T	k
12.25		T	k
12.26		F	u
12.27		F	u
12.28		T	u
12.29		T	k
12.30		T	k
12.31		F	k
12.32		F	u
12.33		F	k
12.34	(a)	(iii)	k
	(b)	(i)	k
	(c)	(ii)	k
	(d)	(v)	k
12.35	(a)	(ii)	k
	(b)	(iii)	k
	(c)	(i)	k
12.36	(a)	(iii)	u
	(b)	(i)	u
	(c)	(v)	u
	(d)	(ii)	u
12.37			k
12.38			k
12.39			u
12.40			k
12.41			u
12.42			k
12.43			k
12.44			k
12.45			u
12.46			k
12.47			k
12.48			k
12.49			u
12.50			k
12.51			an
12.52	(a)	$CoCl_2 6H_2O + NH_3(aq) + NH_4NO_3(aq) + H_2O_2(aq) \rightarrow [(Co(NH_3)_5 NO_2)] Cl_2 + H_2O$	
	(b)	Nitrotopentamminecobalt (III) chloride	
	(c)	linkage	

Item	*Key*	*Ability*
(d)	6	
(e) (i)	d^2sp^3	
(ii)	octahedral	

UNIT 13

13.1	(d)	k
13.2	(d)	u
13.3	(b)	u
13.4	(a)	ap
13.5	(b)	k
13.6	(b)	u
13.7	(d)	u
13.8	(c)	ap
13.9	(a)	k
13.10	(d)	k
13.11	(d)	k
13.12 (a) (i)	+ 2	
(ii)	4	
(b) (i)	no	k
(ii)	no	k
(c)	left	k
(d)	$N = N_0 e^{-\lambda t}$	k
(e)	independent	k
13.13 (a)	neutrons	u
(b) (i)	graphite	k
(ii)	D_2O	k
(c) (i)	boron steel	k
(ii)	cadmium	k
(d) (i)	neutrons	k
(ii)	radiosotope	k
(e) (i)	deuterium	k
(ii)	helium	k
13.14 (a)	${}^{4}_{2}\mathrm{He}$	u
(b)	${}^{14}_{7}\mathrm{N}$	u

Item		*Key*	*Abilities*
	(c)	${}^{0}_{-1}e$	u
	(d)	$8\,{}^{4}_{2}He$	u
	(e)	${}^{12}_{6}C$	u
13 15	(a)	T	u
	(b)	F	k
	(c)	F	k
	(d)	F	u
	(e)	F	k
13 16	(a)	F	k
	(b)	F	k
	(c)	T	k
	(d)	T	k
	(e)	F	k
13.17	(a)	(ii)	u
	(b)	(i)	u
	(c)	(iii)	u
13.18	(a)	(v)	k
	(b)	(i)	k
	(c)	(ii)	k
	(d)	(iv)	k
13 19			k
13 20			an
13.21			u
13.22			an
13.23			k
13.24			u
13.25			an
13.26			ap
13.27			k
13 28			k
13 29			k
13.30			k
13.31			k
13.32			k
13.33		0.033 day^{-1}	
13.34		2.22 h	
13.35		20996 years	

Item			*Key*	*Ability*
13 36			0.0013 g	
13.37			28.3024 Mev	
13 38			1.14×10^9 years	
13.39		(i)	1.75×10^3 kg	
		(ii)	9.33×10^{-4} g	

UNIT 14

Item			*Key*	*Ability*
14.1			(d)	k
14 2			(a)	k
14 3.			(c)	k
14.4			(d)	k
14 5			(d)	k
14 6			(c)	k
14.7			(b)	k
14.8			(c)	k
14.9			(b)	k
14 10			(d)	k
14.11			(a)	k
14.12			(b)	k
14.13			(c)	k
14.14			(a)	k
14 15			(d)	k
14 16			(d)	k
14 17			(d)	k
14.18	(a)	(i)	metaphosphoric acid	k
		(ii)	silicates	k
		(iii)	silicones	k
	(b)		amino acids	k
	(c)		addition	k
	(d)	(i)	condensation	k
		(ii)	water	k
	(e)	(i)	initiators	k
		(ii)	free radicals	
14.19	(a)		weakest	k
	(b)		Thermosetting	k
	(c)	(i)	hexamethylene diamine	
		(ii)	adipic acid	

Item		*Key*	*Abilities*
	(d)	Buna-S	
	(e)	caprolactam	
14.20	(a)	T	k
	(b)	F	k
	(c)	F	k
	(d)	F	k
	(e)	F	k
14.21	(a)	F	k
	(b)	T	k
	(c)	F	k
	(d)	T	k
	(e)	F	
14.22	(a)	(v)	k
	(b)	(vi)	k
	(c)	(iii)	k
	(d)	(ii)	k
	(e)	(iv)	k
14.23	(a)	(v)	k
	(b)	(i)	k
	(c)	(ii)	k
	(d)	(iii)	k
	(e)	(iv)	k
14.24			k
14.25			k
14.26			k
14.27			u
14.28			k
14.29			k
14.30			u
14.31			u
14.32			k
14.33			k
14.34			k
14.35			k
14.36			k
14.37			k
14.38			k
14.39			
14.40			k
14.41			
14.42			k

Item		*Key*	*Ability*
14.43			k
14.44			k
14.45			k

UNIT 15

15 1		(b)	k
15 2		(d)	k
15 3		(b)	k
15 4		(c)	k
15.5		(d)	k
15 6		(c)	k
15.7		(a)	k
15 8		(a)	k
15.9		(c)	k
15 10		(d)	k
15.11		(c)	k
15 12		(b)	k
15.13		(c)	k
15.14		activation energy	k
15 15		$\left(\frac{1}{n}\right)\log p$	k
15.16		adsorption isobar	k
15.17		moisture	k
15 18		$kc^{\frac{1}{n}}$	k
15.19		(a) disperse phase (b) dispersion medium	
15.20		chemical adsorption	u
15.21		macromolecular	k
15 22		electrolytes	k
1.23	(i)	oil in water	k
	(ii)	water in oil	k
15.24		selectivity	k
15.25		pore structure	k
15.26		gels	k
15.27		Brownian movement	k
15.28		surface catalysis	k
15 29		lyophobic	k

Item		*Key*	*Abilities*
15.30		gaseous	k
15.31		gases	k
15 32		collodion	k
15.33		T	k
15.34		F	k
15.35		F	k
15.36		T	k
15.37		T	k
15.38		F	k
15.39		T	u
15 40		T	k
15.41		F	k
15 42		T	k
15 43		F	k
15.44		F	u
15 45	(a)	(iv)	u
	(b)	(iii)	u
	(c)	(ii)	u
	(d)	(v)	u
15 46	(a)	(iii)	u
	(b)	(i)	u
	(c)	(ii)	u
	(d)	(vi)	u
15 47			k
15 48			k
15 49			k
15 50			k
15 51			u
15 51			u
15 52			k
15.54			k
15 55			k
15 56			k
15.57			k
15 58			k
15 59			u
15.60			k
15.61			k
25 62			k
15.63			k
15 64			k

Item	*Key*	*Abilities*
15.65		k
15.66		k
15.67		k
15.68		k
15.69	$k = 0.160$; $n = 2.32$	
15.70	$5.50 \times 10^{+4}$ cm^2	

UNIT 16

Item		*Key*	*Abilities*
16.1		(b)	k
16.2		(b)	u
16.3		(a)	k
16.4		(c)	k
16.5		(a)	k
16.6		(b)	k
16.7		(a)	
16.8		(b)	k
16.9		(b)	k
16.10		(d)	k
16.11		(d)	k
16.12		(c)	k
16.13		(d)	k
16.14		(d)	k
16.15		(c)	k
16.16		(a)	k
16.17		(d)	k
16.18		(d)	u
16.19		di	k
16.20		β glucose	k
16.21	(i)	10	k
	(ii)	20	k
16.22		denaturation	k
16.23		nucleotides	k
16.24	(i)	adenine	
	(ii)	guanine	k
16.25	(i)	replication	k
	(ii)	protein synthesis	k

Item		*Key*	*Abilities*
16.26		codon	k
16.27		genetic code	k
16.28		double helix	k
16.29		mutation	k
16.30		messenger	k
16.31		complex lipids	k
16.32		triglycerides	
16.33		T	k
16.34		F	u
16.35		F	u
16.36		F	k
16.37		T	k
16.38		T	k
16.39		F	k
16.40		T	k
16.41		T	k
16.42		T	k
16.43		F	k
16.44		T	u
16.45	(a)	(iv)	k
	(b)	(i)	k
	(c)	(v)	k
	(d)	(ii)	k
16.46	(a)	(i)	k
	(b)	(iii)	k
	(c)	(ii)	k
	(d)	(v)	k
16.47			k
16.48			u
16.49			k
16.50			k
16.51			k
16.52			u
16.53			k
16.54			k
16.55			k
16.56			k
16.57			u
16.58			k
16.59			k
16.60			an

Item	*Key*	*Abilities*
16 61		k
16 62		k
16 63		u
16.64		u
16.65		u
16 66		k
16.67		u
16.68		k

UNIT 17

17 1	(b)	k
17 2	(d)	k
17 3	(c)	k
17 4	(d)	k
17 5	(c)	k
17.6	(a)	k
17 7	(b)	k
17 8	(b)	k
17 9	(a)	k
17.10	(a)	k
17.11	(b)	k
17.12	(d)	k
17.13	(d)	k
17 14	(c)	k
17.15	(c)	k
17 16	(a)	k
17 17	(d)	k
17 18	(d)	k
17 19	(a)	k
17.20	(c)	k
17 21	(b)	k
17 22	(d)	k
17 23	(a)	k
17 24	(c)	k
17 25	(b)	k
17 26	(a)	k
17 27	(a)	k

Item		*Key*	*Abilities*
17.28		(a)	k
17.29		(b)	k
17.30		(d)	k
17.31		(b)	k
17.32		catabolism	k
17.33		adenosine triphosphate	k
17.34		photosynthesis	k
17.35		(i) acidic	k
17.36		bile fluid	k
17.37		cytoplasm	k
17.38		ATP	k
17.39		(i) proteases	k
		(ii) peptidases	k
17.40		cellular respiration	k
17.41		ascorbic acid	k
17.42		(i) B-complex and C	
		(ii) A, D, E and K	
17.43		A	k
17.44		stunted growth	
17.45		scurvy	
17.46		depollutant	k
17.47		F	
17.48		T	k
17.49		T	k
17.50		T	k
17.51		F	k
17.52		T	k
17.53		F	k
17.54		T	k
17.55		F	k
17.56		F	k
17.57		F	
17.58		T	an
17.59	(a)	(iv)	k
	(b)	(i)	k
	(c)	(ii)	k
	(d)	(v)	k
17.60	(a)	(i)	k
	(b)	(iv)	k
	(c)	(ii)	k
	(d)	(v)	k

Item	*Key*	*Abilities*
17.61		k
17.62		k
17.63		k
17.64		k
17.65		k
17 66		k
17.67		k
17.68		k
17.69		k
17 70		k
17.71		u
17.72		u
17.73		k
17.74		k
17.75		k
17 76		k
17.77		an
17 78		an

UNIT 18

18 1	(c)	k
18.2	(c)	k
18 3	(a)	k
18.4	(d)	u
18.5	(a)	k
18 6	(b)	k
18 7	(d)	k
18 8	(b)	k
18.9	(a)	k
18.10	(a)	k
18.11	(c)	k
18.12	(c)	k
18 13	(a)	u
18.14	(b)	k
18.15	(a)	k
18.16	(a)	k
18.17	(a)	k

Item		*Key*	*Abilities*
18.18		(c)	
18.19		(c)	k
18.20		(a)	k
18.21	(i)	aluminium	k
	(ii)	blue	
	(iii)	(a) diazotized	k
		4-Aminobenzenesulphonic acid	k
		(b) α - naphthol	4
	(iv)	(a) amino	k
		(b) acid	k
	(v)	hydrogen bonds	k
18.22	(i)	2-Acetoxybenzoic acid	k
	(ii)	hypertension or high blood pressure	k
	(iii)	antipyretic	k
	(iv)	relieving pain	k
	(v)	alocohol-water	k
18.23	(i)	sulphur dioxide	k
	(ii)	tranquilizing	k
	(iii)	penicillin	
	(iv)	(i) 2-Hydroxybenzoic acid	k
		(ii) bleeding or ulcer	k
	(v)	(i) Hindustan Antibiotics, Pimpri	
		(ii) Indian Drugs and Pharmaceuticals, Rishikesh	k
18.24	(i)	(a) an oxidiser	k
		(b) fuel	k
	(ii)	nitrocelluclose	
	(iii)	(a) unsymmetrical dimethylhydrazine	k
		(b) monomethylhydrazine	k
	(iv)	composite solid propellants	k
	(v)	monopropellants	k
18.25		T	k
18.26		F	k
18.27		T	k
18.28		T	k
18.29		T	k
18.30		F	k
18.31		T	u
18.32		T	k
18.33		T	k
18.34		T	k
18.35		T	k

Item		*Key*	*Abilities*
18.36		F	k
18.37		F	k
18.38	(a)	(iii)	k
	(b)	(iv)	
	(c)	(ii)	k
18.39	(a)	(vi)	
	(b)	(iv)	k
	(c)	(iii)	k
	(d)	(v)	k
	(c)	(v)	k
18.40	(a)	(iii)	j
	(b)	(i)	k
	(c)	(iv)	k
	(d)	(ii)	k
18.41			u
18.42			u
18.43			k
18.44			k
18.45			k
18.46			k
18.47			k
18.48			k
18.49			k
18.50			k
18.51			k
18.52			k
18.53			k
18.54			k
18.55			k
18.56			k
18.57			k
18.58			k
18.59			k
18.60			
18.61			
18.62			
18.63			sn
18.64			k
18.65			an
18.66			k

SOLUTIONS TO NUMERICAL PROBLEMS AND PROBLEM TYPE ITEMS

UNIT 1

1.83 $$\lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{10^{-3} \times 10^{-2}} \; \frac{\cancel{kg}\,m^{\cancel{2}}\,\cancel{s^{-1}}}{\cancel{kg}\,\cancel{m}\,\cancel{s^{-1}}}$$

$$= 6.6 \times 10^{-29}\,m$$

1.84 $$\Delta p\,\Delta x = \frac{h}{4\pi}$$

$$\text{i.e. } \Delta p = \frac{h}{4\pi\Delta x}$$

$$= \frac{6.6 \times 10^{-34}}{4 \times 3.142 \times 0.1 \times 10^{-9}} \; \frac{kg\,m^{\cancel{2}}\,s^{-1}}{\cancel{m}}$$

$$= \frac{6\;6}{4 \times 3.142} \times 10^{-24}\,kg\,m\,s^{-1}$$

$$= 0.53 \times 10^{24}\,kg\,m\,s^{-1}$$

$$= 5.3 \times 10^{-25}\,kg\,m\,s^{-1}$$

1.85 $$\Delta p = m\,\Delta v$$

$$= 9.1 \times 10^{-31} \times \frac{0.004}{10\cancel{0}} \times 60\cancel{0}\,kg\,m\,s^{-1}$$

$$= 9.1 \times 0.004 \times 6 \times 10^{-31} \quad kg\,m\,s^{-1}$$

$$\Delta x\;\Delta p = h/4\pi$$

$$\Delta x = \frac{h}{4\pi} \cdot \frac{1}{\Delta p}$$

$$= \frac{6\;6 \times 10^{-34}\;\cancel{kg}\,m^{\cancel{2}}\,\cancel{s^{-1}}}{4 \times 3.142 \times 9.1 \times 0.004 \times 6 \times 10^{-31}\;\cancel{kg}\,\cancel{m}\,\cancel{s^{-1}}}$$

$$= 2.4 \times 10^{-3}\,m$$

1.86 (a)

$$
\begin{aligned}
\Delta E &= E_3 - E_2\\
&= -1.312\times10^{6}\left(\frac{1}{3^2}-\frac{1}{2^2}\right)\text{ J mol}^{-1}\\
&= +\,1.82\times10^{5}\text{ J mol}^{-1}
\end{aligned}
$$

(b)

$$
\begin{aligned}
\Delta E &= E_1 - E_3\\
&= +\,1.312\times10^{6}\left(\frac{1}{3^2}-\frac{1}{1^2}\right)\text{ J mol}^{-1}\\
&= -\,1.17\times10^{6}\text{ J mol}^{-1}
\end{aligned}
$$

$$
\begin{aligned}
\text{Frequency} &= \frac{\Delta E}{h}\\
&= \Delta\,\frac{E/N}{h}\;\frac{\cancel{J}\,\cancel{\text{mol}^{-1}}/\cancel{\text{mol}^{-1}}}{\cancel{J}s}\\
&= \frac{1\ 17\times10^{6}/6.023\times10^{23}}{6.6\times10^{-34}}\,s^{-1}\\
&= 0\ 029\times10^{17}\,s^{-1}\\
&= 29\times10^{14}\,s^{-1}
\end{aligned}
$$

(c)

$$
\begin{aligned}
\text{wavelength} &= \frac{\text{velocity}}{\text{frequency}}\\
&= \frac{3\times10^{8}\ \text{m}\cancel{s}^{-1}}{29\times10^{14}\ \cancel{s}^{-1}}\\
&= 0\ 103\times10^{-6}\text{ m}\\
&= 103\text{ nm}
\end{aligned}
$$

1 87

$$
\begin{aligned}
\text{wavelength} &= \frac{\text{velocity}}{\text{frequency}}\\
&= \frac{\text{velocity}}{\Delta E/h}\\
&= \frac{\text{velocity}}{\dfrac{\Delta E/N}{h}}\\
&= \frac{3\times10^{8}\ \text{m}\cancel{s^{-1}}}{\dfrac{0.52\times10^{6}/6.023\times10^{23}}{6\ 6\times10^{-34}}\;\dfrac{\cancel{J}\,\cancel{\text{mol}^{-1}}/\cancel{\text{mol}^{-1}}}{\cancel{J}\cancel{s}}}\\
&= 230\ 2\times10^{-9}\text{ m}\\
&= 230\ 2\text{ nm}
\end{aligned}
$$

1.88 (a)

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.63 \times 10^{-34}\ \cancel{kg}\, m^{\cancel{2}}\, \cancel{s^{-1}}}{(9\ 1 \times 10^{-31}\ \cancel{kg})\ (4.0 \times 10^{4}\ \cancel{m}\, \cancel{s^{-1}})}$$

$$= 1.8 \times 10^{8}\ m$$

$$= 18\ nm.$$

(b)

$$v = 2.0\ m\ s^{-1}$$

$$m = 1\ 5 \times 10^{6}\ kg$$

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.63 \times 10^{-34}\ \cancel{kg}\, m^{\cancel{2}}\, \cancel{s^{-1}}}{(1.5 \times 10^{-6}\ \cancel{kg})\ (2.0\ \cancel{m}\, \cancel{s^{-1}})}$$

$$= 2.2 \times 10^{-28}\ m$$

$$= 2\ 2 \times 10^{19}\ nm$$

Since λ in case (b) is much smaller than that of an electron [case (a)] one can safely ignore the wavelength of a bug.

UNIT 2

2.86 (i) A hard sphere with its centre located at the corner of a cube contributes only $\frac{1}{8}$ of its volume to the cube There are 8 corners to a cube.

.. The 8 corner atoms (schematically represented as hard spheres) contribute $8 \times \frac{1}{8} = 1$ atom/cube.

Thus, the number of atom/unit cell in cubic arrangement is 1.

(ii) In a body centred cube unit cell, there is 1 atom in the centre, as well as, 8 at the corners. The 8 corner atoms contribute $\frac{1}{8}$ of each to the unit cell, so there is a contribution of $8 \times \frac{1}{8} = 1$ atom from this source

∴ The total number of atoms/unit cell is 1+1= 2

(iii) There are 6 faces to a cube, each with one atom. Each face of a cubic unit cell is shared by the adjoining unit cell.

∴ the atom at the face centre position contributes $\frac{1}{2}$ to each cell

∴ contribution of all the atoms at the faces = $\frac{1}{2} \times 6 = 3$.

The 8-corner atoms contribute $8 \times \frac{1}{8} = 1$ atom/cube.

Hence, the total number of atom/unit cell, in a face centred cubic arrangements is 3 + 1 = 4

2.87 The volume of the unit cell is $(36.08\text{nm})^3 = (36.08 \times 10^{-9}\text{m})^3 = 4\ 697 \times 10^{23}\ \text{m}^3$
The unit cell in face centred cubic contain 4 atoms,

$$\text{Volume/atom} = \frac{4.697 \times 10^{-23}\ \text{m}^3}{4\ \text{atom}}$$

$$= 1.174 \times 10^{-23}\ \text{m}^3/\text{atom}$$

∴ for 6 02 × 10^{23} atoms volume will be

$$= 1\ 174 \times 10^{-23}\ \frac{\text{m}^3}{\cancel{\text{atom}}} \times 6\ 02 \times 10^{+23}\ \cancel{\text{atom}}$$

$$= 7\ 07\ \text{m}^3$$

2.88 Volume of unit cell is $(407.8 \times 10^{-12}\text{m})^3$

$$= (40.78 \times 10^{-9}\ \text{cm})^3$$

$$= 6.782 \times 10^{-23}\ \text{cm}^3$$

Face centred cubic arrangement has 4 atoms/unit cell

∴ effective volume/atom is $\frac{6.782 \times 10^{-23}\ \text{cm}^3}{4\ \text{atom}}$

$$= 1\ 696 \times 10^{-23}\ \text{cm}^3/\text{atom}.$$

The volume occupied by 1 mol of silver atom would be,

$$6\ 02 \times 10^{23}\ \cancel{\text{atom}}\ \text{mol}^{-1} \times 1\ 696 \times 10^{-23}\ \frac{\text{cm}^3}{\cancel{\text{atom}}}$$

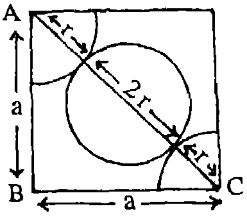
$$= 10.2\ \text{cm}^3\ \text{mol}^{-1}$$

$$\therefore \quad \text{density} = \frac{107.87\ \text{g}\ \cancel{\text{mol}^{-1}}}{10.2\ \text{cm}^3\ \cancel{\text{mol}^{-1}}}$$

$$= 10\ 6\ \text{g/cm}^3$$

2 89 Let a be the length of the side of the cube (see figure), and r the radius of the atom

Applying Pythogorus' theorem to ΔABC,



$$2a^2 = (4r)^2$$
or $$2a^2 = 16r^2$$
or $$a^2 = 8r^2$$
or $$a = 2\sqrt{2}r$$
Since $$a = 40.7\text{nm}$$
$$\therefore \quad 40.70\text{nm} = 2\sqrt{2}r \text{ or } r = 14.53\text{nm}$$

2.90 As is shown in problem 2.86 (iii) the total number of atoms per unit cell in a face centred cubic arrangement is 4.

Let the radius of each atom in the unit cell be r.

Then, volume v of each atom $= \frac{4}{3}\pi r^3$

and the volume occupied by 4 atoms will be $4 \times \frac{4}{3}\pi r^3$

$$= \frac{16}{3}\pi r^3$$

Let the edge length of the "face" be a.

Then, as shown in problem 2.89, $a = 2\sqrt{2}r$

- volume of the entire cell $a^3 = 8r^3\left(\sqrt{2}\right)^3 = 16\sqrt{2}\,r^3$

$\therefore$ Packing efficiency defined as $\frac{V_{sphere}}{V_{cell}}$ or the fraction of the unit cell occupied by the

atoms $= \dfrac{\frac{\cancel{16}}{3}\pi \cancel{r^3}}{\cancel{16}\cancel{r^3}\sqrt{2}} = \dfrac{\pi}{3\sqrt{2}} = 0.74$

$= 74\%$

2.91

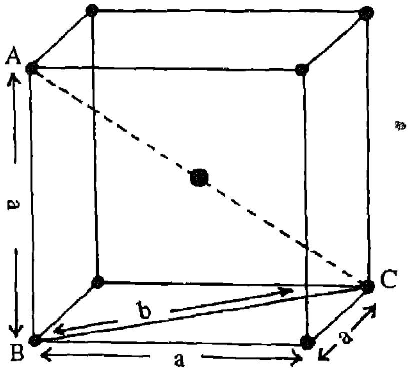


Fig (a)

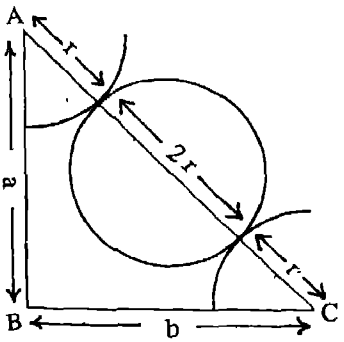


Fig. (b)

From ΔBCD, (Fig. a)

$$a^2 + a^2 = b^2$$

or $$2a^2 = b^2$$

From ΔABC [Fig (b)]

$$a^2 + b^2 = AC^2$$

or $$a^2 + 2a^2 = AC^2$$

or $$3a^2 = AC^2$$

or $$AC = a\sqrt{3}$$

Since $AC = 4 \times r$ $\quad \therefore a\sqrt{3} = 4 \times r$

$$\therefore \quad \text{radius } r = \frac{a\sqrt{3}}{4} = \frac{\sqrt{3}}{4}(353)\text{pm}$$

$$= 152.9 \text{ pm}$$

(ii) Since, $4r = a\sqrt{3}$ (as shown above)

$$a = \frac{4\ r}{\sqrt{3}}$$

$$\therefore \quad a^3 = \frac{(4r)^3}{(\sqrt{3})^3} = \frac{64r^3}{3\sqrt{3}}$$

As shown in Problem 2.86 in a body centred cubic lattice structure, there are 2 atoms/unit cell

Since, volume of each atom $= \frac{4}{3}\pi r^3$ (r being the radius of an atom)

$$\therefore \quad \text{Volume of 2 atoms} = 2 \times \frac{4}{3}\pi r^3 = \frac{8}{3}\pi r^3$$

$$\text{Packing efficiency} = \frac{\text{volume of atom / unit cell}}{\text{volume of the unit cell}}$$

$$= \frac{\frac{8}{\cancel{3}}\pi \cancel{r^3}}{\frac{64}{\cancel{3}\sqrt{3}}\cancel{r^3}}$$

$$= \frac{\pi\sqrt{3}}{8} = 0.68 = 68\%$$

2.92 Volume of unit cell is $(352.39)^3\ 10^{-30}\ \text{cm}^3$.
Being a face centred cell, this has 4 atoms [Problem 2.86 (iii)]
Density of the element being $8.9\ \text{g cm}^{-3}$

Mass of each in atom of the element is $\frac{1}{4} \times \frac{8.9\,g}{\cancel{cm^3}} (352.39)^3 \times 10^{-30} \cancel{cm^3}$

Since Avagadro constant = $\frac{\text{atomic mass}}{\text{mass of each atom}}$

$\therefore$ Avagadro constant = $\frac{58.7\cancel{g}}{mol} \times \frac{4}{(8.9)\cancel{g}(352\ 39)^3 \times 10^{-30}}$

$= 6.03 \times 10^{23}\ mol^{-1}$

2.93 Edge length of the cell is 630 pm

Density of the substance is 1 984 g cm^{-3}

Being a face centred cubic crystals there are 4 atoms per unit cell.

$\therefore$ mass of each atom is $\frac{1}{4} \times \frac{1.984\,g}{\cancel{cm^3}} \times (630)^3 \times 10^{-30} \times \cancel{cm^3}$

$\therefore$ molar mass of the substance is

$6.02 \times 10^{23}\ mol^{-1} \times \frac{1}{4} \times 1.984\ g \times (630)^3 \times 10^{-30}$

$= 74.7\ g\ mol^{-1}$

2 94 **Anion B:** (i) There are 8 corners of the cell and each corner is shared by 8 nearby cells.

$\therefore$ contribution of anion (B) from the corner = $\frac{1}{8} \times 8 = 1$

(ii) The anion (B) at the centre of the unit cell belongs entirely to this cell.

.. Total number of anion (B)/unit cell 1+1 = 2.

Cation A: There are 6 faces of the cubic.

There are 6 cations (A) But each cation on each face is shared between 2 nearby unit cells.

Contribution of cation (A) unit cell = $6\ (\frac{1}{2}) = 3$.

$\therefore$ there are 3 cations (A) and 2 anions (B) per unit cell

$\therefore$ the simplest formula is A_3B_2.

UNIT 3

3.92 mass of sugar = 34.2 g

mass of syrup = 214.2 g

$$\therefore \quad \text{mass of water} = (214.2 - 34.2)\ \text{g} = 180.0\ \text{g}.$$

$$\text{No. of moles of sugar} = \frac{\text{mass of sugar}}{\text{molar weight}}$$

$$= \frac{34.2\,\cancel{\text{g}}}{342\,\cancel{\text{g}}\,\text{mol}^{-1}} = 0.1\ \text{mol}$$

(i) $$\text{molality } m_B = \frac{1000 \times n_B}{w_A}$$

$$= \frac{1000 \times 0.1\ \text{mol}}{180.0\,\text{g}} = 0.56\ \text{mol kg}^{-1}$$

(ii) $$\text{mole fraction of sugar } x_B = \frac{\text{moles of sugar}}{\text{moles of (sugar + water)}}$$

$$\text{mols of sugar} = 0.1$$

$$\text{mols of water} = \frac{180}{18} = 10.0$$

$$\therefore \quad x_B = \frac{0.1\,\cancel{\text{mol}}}{10.1\,\cancel{\text{mol}}} = 0.01$$

3.93 $2\ \text{HCl} + \text{Na}_2\text{CO}_3 \rightarrow 2\ \text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}$

If M_1 and M_2 are the respective molarities of the acid and the alkali and V_1 cm^3 and V_2cm^3 are their respective volumes, then $\frac{M_1 V_1}{M_2 V_2}$ = mole ratio

The number of mols of Na_2CO_3 in the given solution is,

$$\frac{10.6\,\cancel{\text{g}}}{106\,\cancel{\text{g}}\,\text{mol}^{-1}} = 0.1\ \text{mol}$$

$$\therefore \quad M_2 = \frac{0.1\ \text{mol}}{0.1\text{L}} = 1\ \text{mol L}^{-1}$$

Since in the given case, the mole ratio of the acid to the base is 2,

$$\frac{M_1 V_1}{M_2 V_2} = 2$$

$$\therefore \quad M_1 V_1 = 2 \times (M_2 V_2)$$

$$\text{or} \quad M_1 = \frac{2(M_2 V_2)}{V_1}$$

$$= \frac{\cancel{2}\,(1\,\text{mol L}^{-1} \times \cancel{25.0\,\text{cm}^3})}{\cancel{50.0\,\text{cm}^3}}$$

$$= 1\ \text{mol L}^{-1}$$

or the molarity of the acid is 1M. The acid being HCl, it is a monobasic acid, and its molarity will be the same as its normality. .. the acid is of strength 1N
Let the volume of HCl to be diluted be V

$$\because \quad V \times 10\ \cancel{N} = 500\ cm^3 \times 1\ \cancel{N}$$

$$\text{or} \qquad V = \frac{50\cancel{0}\ cm^3}{1\cancel{0}} = 50\ cm^3$$

∴ 50.0 cm³ of 10 N HCL is diluted to 500.0 cm³ by adding 450.0 cm³ of water.

3.94 Mass of solution/dm³ = 1009 7g
mass of ethanoic acid/dm³ = 80.8g
∴ mass of water in 1 dm³ of solution = mass of solution – mass of acid
= (1009.7 – 80.8) g = 928 9 g

$$\text{mols of water} = \frac{\text{mass of water}}{\text{molar mass}} = \frac{928\ 9\cancel{g}}{18\cancel{g}\ mol^{-1}}$$

= 51.60 mol

$$\text{mols of ethanoic acid} = \frac{80.8\cancel{g}}{60\cancel{g}/mol^{-1}} = 1.35\ mol$$

Total mols of acid + water = 1.35 mol + 51 60 mol
= 52.95 mol

$$\text{(i) mass per cent of water} = \frac{\text{mass of water}}{\text{total mass of solution}} \times 100$$

$$= \frac{928.9\cancel{g}}{1009.7\cancel{g}} \times 100$$

= 92.00%

mass per cent of ethanoic acid

$$= \frac{80.8\ g}{1009.7\ g} \times 100 = 8.0\ \%$$

(or, 100 – 92.0 = 8.0%)

$$\text{(ii) mole fraction of ethanoic acid} = \frac{1.35\ mol}{52.95\ mol} = 0.025$$

$$\text{mole fraction of water} = \frac{51.60}{52.95} = 0.97$$

$$\text{(iii) molality of ethanoic acid} = \frac{1000 \times 1.35\ mol}{928\ 9} = 1.45\ mol\ kg^{-1}$$

(iv) partial vapour pressure of ethanoic acid = vapour pressure of pure acid × mole fraction of ethanoic acid

$$= 100 \text{ mm} \times 0.025$$
$$= 2.5 \text{ mm of Hg}$$

(v) partial vapour pressure of water = total vapour pressure − partial vapour pressure of ethanoic acid

$$= 125 \text{ mm} - 2.5 \text{ mm}$$
$$= 122.5 \text{ mm}$$

(vi) vapour pressure of pure water $= \dfrac{\text{partial pressure of water}}{\text{mole fraction of water}}$

$$= \frac{122.5 \text{ mm}}{0.97} = 126.29 \text{ mm}$$

3.95 We know that $p_A = p_A^\circ x_A$ and $p_B = p_B^\circ x_B$
where, p_A and p_B are the partial vapour pressures of A and B,
p_A° and p_B° are the vapour pressures of pure A and B
and x_A and x_B are the mole fractions of A and B,
respectively

$\therefore$ $p_A + p_B = p_A^\circ x_A + p_B^\circ x_B$

When molar ratio is 1:1, $x_A = x_B = \dfrac{1}{2}$

and $p_A + p_B = 350$ mm

or $\dfrac{1}{2}(p^\circ_A + p^\circ_B) = 350$ mm

$\therefore$ $p_A^\circ + p_B^\circ = 700$ mm ... (i)

when molar ratio is 1 : 2

$$p_A = p^\circ_A \cdot \frac{1}{3} \text{ and } p_B = p^\circ_B \cdot \frac{2}{3}$$

or $p_A + p_B = \dfrac{1}{3} p^\circ_A + \dfrac{2}{3} p^\circ_B$ but $p_A + p_B = 300$ mm

$\therefore$ $\dfrac{1}{3} p^\circ_A + \dfrac{2}{3} p^\circ_B = 300$ mm

or $p_A^\circ + 2 p_B^\circ = 900$ mm ... (ii)

from equation (i) $p^\circ_A = 700 - p^\circ_B$. Substituting this value of p_A° in equation (ii) we get

$700 - p_B^\circ + 2p_B^\circ = 900$. Rearranging,

$p_B^\circ = 900 - 700 = 200$ mm

Substituting the value of p_B° in equation (i)

$p_A^\circ + 200 = 700$ $\therefore$ $p_A^\circ = 700 - 200$

or $\quad p_A^\circ = 500$ mm

So, the vapour pressure of pure A and B at the given temperature are 500 mm and 200 mm of Hg, respectively.

3.96 Molecular mass of $C_6H_8O_2N_2S$ is 172 g mol^{-1}
Molecular mass of C_3H_6O is 58 g mol^{-1}

$$\therefore \quad 1 \text{ g of } C_6H_8O_2N_2S \text{ is } \frac{1\,\text{mol}}{172\cancel{g}} \times 1\cancel{g} = 5.81 \times 10^{-3} \text{ mol.}$$

$$10 \text{ g of } C_3H_6O \text{ is } \frac{1\,\text{mol}}{58.0\cancel{g}} \times 10\cancel{g} = 0.172 \text{ mol}$$

Mole fraction of C_3H_6O in solution is

$$\frac{0.172\,\text{mol}}{0.172\,\text{mol} + 5.81 \times 10^{-3}\,\text{mol}} = 0.966$$

By Raoult's law,

$$\begin{aligned} \text{Vapour pressure} &= \text{mole fraction} \times \text{vapour pressure of pure } C_3H_6O \\ &= 0.966\,(4.00 \times 10^2 \text{ mm Hg}) \\ &= 3.87 \times 10^2 \text{ mm Hg} \end{aligned}$$

3.97 Let x g mol^{-1} be the molar mass of the polymer

$$\therefore \text{ No. of moles of the polymer} = \frac{5\cancel{g}}{x\cancel{g}\,\text{mol}^{-1}}$$

Using $\pi V = nRT$, where π is the osmotic pressure
V is the volume
n is the no. of moles of A
R is the gas constant = 8.31 kPa dm^3 mol^{-1} K^{-1}
T the absolute temperature

$$\text{We have } 0.096\,\cancel{\text{kPa}} \times 1\,\cancel{\text{dm}^3} = \frac{5}{x}\,\cancel{\text{mol}} \times 8.31\,\cancel{\text{kPa}}\,\cancel{\text{dm}^3}\,\cancel{\text{mol}^{-1}}\,\cancel{\text{K}^{-1}} \times 288\,\cancel{\text{K}}$$

$$\text{or} \quad x = \frac{5 \times 8.31 \times 288}{0.096}$$

$$= 1.25 \times 10^5$$

$\therefore$ molecular mass of the polymer is 1.25×10^5 g mol^{-1}.

3.98 Mole fraction of A = $\dfrac{n_2}{n_1 + n_2}$, where n_2 is the number of moles of A and n_1, is the number of moles of water.

No of moles of water $= \dfrac{1.00 \times 10^{2}\,\cancel{g}}{18\,\cancel{g}\ \text{mol}^{-1}}$

$= 5.56\ \text{mol}$

By Raoult's law, mole fraction of A can be calculated from the expression for relative lowering of vapour pressure

$\therefore$ mole fraction of A $= \dfrac{4.24\text{kPa} - 4.16\text{kPa}}{4.24\text{kPa}}$

$= \dfrac{0.08\,\cancel{\text{kPa}}}{4.24\,\cancel{\text{kPa}}} = 1.9 \times 10^{-2}$

or $1.9 \times 10^{2} = \dfrac{n_2\ \text{mol}}{5.56\ \text{mol} + n_2\ \text{mol}}$

or $1.9 \times 10^{-2}\,(5.56 + n_2)\ \cancel{\text{mol}} = n_2\ \cancel{\text{mol}}$

or $n_2 = \dfrac{1.9 \times 10^{-2} \times 5.56}{1 - 1.9 \times 10^{-2}} = 0.11$

$\therefore$ 0.11 mol of A has a mass of 5g

$\therefore$ 1 mol of A is $\dfrac{5\text{g}}{0.11\ \text{mol}} = 45.45\ \text{g mol}^{-1}$

$\therefore$ the molar mass of A is 45.45 g mol^{-1}

3.99 Boiling point elevation is (355.6 – 353.2) K

$= 2.4\text{K}$

Since $\Delta T = K_b\, m$ where m is the molality

ΔT the elevation in boiling point and

K_b the molal boiling point elevation constant

$\therefore\ m = \dfrac{2.4\,\cancel{\text{K}}}{2.53\,\cancel{\text{K}}\ \text{kg mol}^{-1}} = 0.95\ \text{mol kg}^{-1}$

According to given data,

85.0 g of B (solvent) has 7.39 g of A (solute)

$\therefore$ 1000 g of B (solvent) has $\dfrac{7.39\,\cancel{g}}{85.0\,\cancel{g}} \times 1000\text{g}$

$= 86.9\text{g}$

$\therefore$ 0.95 mole has mass of 86.9g

$\therefore$ 1 mole has mass of $\dfrac{86.9\text{g}}{0.95\,\cancel{\text{mol}}} \times 1\ \cancel{\text{mol}} = 91.5\text{g}$

Hence, the molar mass of A is 91.5g mol^{1}.

3.100 0.300 g of urea = $\frac{0.300\cancel{g}}{60\ 1\cancel{g}\text{mol}^{-1}} = 4.99 \times 10^{3}$ mol

10 g of water has 4.99×10^{-3} mol of urea

$\therefore$ 1000 g of water will have $\frac{4.99 \times 10^{-3}}{1\cancel{0}}\text{mol} \times 100\cancel{0}$

$= 0.499$ mol kg^{-1} of urea

$\because$ the molality of urea is .499 m

$$\Delta T_b = K_b\, m$$

$$= (0.52\ \text{K}\ \cancel{\text{kg}}\ \cancel{\text{mol}}^{-1})\ (0.499\ \cancel{\text{mol}}\ \cancel{\text{kg}}^{-1})$$

$$= 26\ \text{K}$$

Since the normal boiling point of water is 373 K

The boiling point of the solution is (373 + 0.26) K = 373.26 K.

3.101 van't Hoff factor (i) = $\frac{\Delta T}{K_f\, m}$, where m is the molality of the solution

The given solution has $\frac{10\cancel{g}}{74.5\cancel{g}/\text{mol}}$ mol of KCl dissolved in 0.1 kg of water

$$\therefore m = \frac{10}{74.5} \times 10\ \text{mol/kg}$$

$$\therefore (i) = \frac{4.5\cancel{K}}{1.86\cancel{K}\,\cancel{kg}\,\cancel{mol}^{-1}} \times \frac{74.5\cancel{kg}}{100\,\cancel{mol}} = 1.8$$

(here = 273 K − 268.5K = 4.5K)

3.102 Assuming complete dissociation of NaCl and MgCl$_2$ i.e., 1 mol of NaCl producing 2 mol of species and 1 mol of MgCl$_2$ producing 3 mol of species, the number of mols of species in water =

$$2 \times \frac{3.5}{58.5} + 3 \times \frac{0.13}{95} \approx 0.12$$

The mass of water in the solution is

100 g − (3.5 + 0.13)g = 96.37 g

$\therefore$ molality of the given solution is

$$= 0.12 \times \frac{1000}{96.37}\ \text{mol/kg}$$

$$= 1.25\ \text{mol/kg}$$

elevation of boiling point, $\Delta T = k_b\, m$

$$= 0.5\text{K}\,\cancel{\text{Kg}}\,\cancel{\text{mol}}^{-1} \times 1.25\,\cancel{\text{mol}}\,\cancel{\text{Kg}}^{-1}$$

$$= .64\ \text{K}$$

normal boiling point of this solution is (373 + 0 64) K =
373.64 K

3.103 Let x g kg^{-1} be the amount of benzoic acid in the solution and let M g mol^{-1} be the molecular mass of benzoic acid ·

$$\text{At boiling point,} \quad m = \frac{\Delta T_b}{K_b} = \frac{2\ 5\cancel{K}}{2.53\cancel{K}\ kg\ mol^{-1}}$$

$$= 0.99\ mol\ kg^{-1}$$

$$\text{At freezing point,}\ m = \frac{\Delta T_f}{K_f} = \frac{2\ 4\cancel{K}}{5.102\cancel{K}\ kg\ mol^{-1}}$$

$$= .47\ mol\ kg^{-1}$$

$$\text{Molality (m) is given as}\ \frac{x\cancel{g}\,kg^{-1}}{M\cancel{g}\,mol^{-1}} = \frac{x}{M} mol\,kg^{-1}$$

$$\cdot\ \text{at boiling point,}\ \frac{x}{M}\ mol\ kg^{-1} = 0.99\ mol\ kg^{-1}\ \text{or}\ M = \frac{x\,\cancel{mol}\,\cancel{kg^{-1}}}{0\ 99\,\cancel{mol}\,\cancel{kg^{-1}}} = 1$$

$$\text{and at freezing point}\ \frac{x}{M}\ mol\ kg^{-1} = .47\ mol\ kg^{-1}\ \text{or}\ M = \frac{x\,\cancel{mol}\,\cancel{kg^{-1}}}{.47\,\cancel{mol}\,\cancel{kg^{-1}}} = 2\ 1$$

Therefore, the molar mass of benzoic acid at freezing point is twice that of its molar mass at boiling point. Thus, we can conclude that at the freezing point benzoic acid exists as a dimer.

UNIT 4

4 63 The required equation for the combustion of propane is

$C_3H_8(g) + 5\ O_2\ (g) \rightarrow 3CO_2(g) + 4H_2O(l)$ ....(1)

.. heat evolved when 1 molar mass of propane (44 g mol^{-1}) is burnt

$$\text{is}\ .\ \frac{105.0\,kJ}{2\ 0\cancel{g}} \times 44\ 0\cancel{g}mol^{-1}$$

$$= 2310\ kJ\ mol^{-1}$$

Since the reaction is carried out at constant volume,

. $\Delta E = -\ 2310\ kJ\ mol^{-1}$

ΔH is calculated from the relation $\Delta H = \Delta E + P\ \Delta\ V$

$P\ \Delta\ V = \Delta n\ \ RT$ (at constant temperature and pressure)

In eqn (i) the volume of water can be neglected in comparison with the volume of gases,

$\because \Delta n = 3 - (1+5) = -3$

Hence, $P\Delta V = \Delta nRT = (-3)\ (8.314\ \text{J}\ \cancel{\text{K}^{-1}}\ \text{mol}^{-1})\ (300\cancel{\text{K}})$

$= -7482.6\ \text{J mol}^{-1} = -7.48\ \text{kJ mol}^{-1}$

$\Delta H = \Delta E + P\Delta V = -2310\ \text{kJ mol}^{-1} - 7.48\ \text{kJ mol}^{-1}$

$= -2317.48\ \text{kJ mol}^{-1}$

4.64 $T_b = \dfrac{\Delta H_{vap}}{\Delta S_{vap}}$

$= \dfrac{7.53 \times 10^3\ \cancel{\text{J}}\ \cancel{\text{mol}^{-1}}}{25\ 7\ \cancel{\text{J}}\ \text{K}^{-1}\ \cancel{\text{mol}^{-1}}}$

$= 293\text{K}$

4 65 The thermochemical equation for the combustion of benzene (g) is

$$C_6H_6(g) + \frac{15}{2} O_2\ (g) \rightarrow 6\ CO_2\ (g) + 3H_2O(l);$$

and $\Delta H = -3344.2$ kJ mol^{-1}

also $\Delta H = 6\Delta H_{f[CO_2(g)]} + 3\Delta H_{[H_2O(l)]} - \Delta H_{f[C_6H_6(g)]}$

or $-3342.2\ \text{kJ mol}^{-1} = 6 \times (-404.8\ \text{kJ mol}^{-1}) + 3 \times (-284\ 5\ \text{kJ mol}^{-1}) - \Delta H_{f[C_6H_6(g)]}$

or $-3344\ 2\ \text{kJ mol}^{-1} = -2428.8\ \text{kJ mol}^{-1} - 853.5\ \text{kJ mol}^{-1} - \Delta H_{f[C_6H_6(g)]}$

or $\Delta H_{f[C_6H_6(g)]} = 3342.2\ \text{kJ mol}^{-1} - 3282.3\ \text{kJ mol}^{-1}$

$= +59.9\ \text{kJ mol}^{-1}$

Heat of formation benzene (g) = + 59.9 kJ mol^{-1}

4 66 From the given data

(i) $H_2(g) \rightarrow 2H(g);\ \Delta H_1 = +436.0\ \text{kJ mol}^{-1}$

(ii) $O_2(g) \rightarrow 2O(g),\ \Delta H_2 = +495\ 2\ \text{kJ mol}^{-1}$

(iii) $H_2(g) + \frac{1}{2} O_2\ (g) \rightarrow H_2O\ (g),\ \ \Delta H_3 = -242.0\ \text{kJ mol}^{-1}$

The bond energy of the O–H bond can be calculated from the following equation in which 2 O–H bonds are broken

(iv) $H_2O(g) \rightarrow 2\ H\ (g) + O(g)\ \ \Delta H = ?$

The above equation can be obtained by carrying out the following operations:

$$\Delta H = (i) + \frac{1}{2}(ii) - (iii)$$

$$\therefore \quad \Delta H = \Delta H_1 + \frac{1}{2}\Delta H_2 - \Delta H_3$$

$$= 436.0 \text{ kJ mol}^{-1} + \frac{495.2 \text{ kJ mol}^{-1}}{2} - (-242\ 0 \text{ kJ mol}^{-1})$$

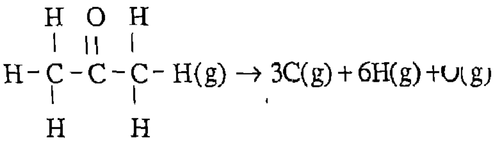
$$= +\ 925.6 \text{ kJ mol}^{-1}$$

Since, 2 O–H bonds are broken in eqn (iv)

$$\therefore \text{ Bond energy of O–H bond} = \frac{+925.6 \text{ kJ mol}^{-1}}{2}$$

$$= +\ 462.8 \text{ kJ mol}^{-1}$$

4 67 In the reaction



$$\mathrm{H{-}\underset{H}{\overset{H}{C}}{-}\overset{O}{\overset{\|}{C}}{-}\underset{H}{\overset{H}{C}}{-}H(g) \rightarrow 3C(g) + 6H(g) + O(g)}$$

6 C–H bonds, 2 C–C bonds and 1 C=O bond are broken.
Hence, heat of reaction

$$\Delta H = 6 \times 415\ 0 \text{ kJ mol}^{-1} + 2 \times 347\ 0 \text{ kJ mol}^{-1} + 707.0 \text{ kJ mol}^{-1}$$

$$= 2490.0 \text{ kJ mol}^{-1} + 694.0 \text{ kJ mol}^{-1} + 707.0 \text{ kJ mol}^{-1}$$

$$= 3891 \text{ kJ mol}^{-1}$$

4 68 The required equation for the phase transition is

$$H_2O(s) \rightleftharpoons H_2O\ (l)$$

$$\Delta s_{fus} = \frac{\Delta H_{fus}}{T}$$

Here $\Delta H_{fus} = 6.0 \text{ kJ mol}^{-1}$ and $T = 273$ K

$$\therefore \quad \Delta s_{fus} = \frac{6.0 \times 10^3 \text{ J mol}^{-1}}{273 \text{ K}}$$

$21.98 \text{ J mol}^{-1} \text{ K}^{-1}$

4.69 $\Delta H^+ (aq) + OH^- (aq) \rightarrow H_2O\,(l)$

$$\Delta H^\circ = \Delta H^\circ_{f[H_2O(l)]} - \Delta H^\circ_{f[H^+(aq)]} - \Delta H^\circ_{f[OH^-(aq)]}$$

or $\quad -57 \text{ kJ mol}^{-1} = -286 \text{ kJ mol}^{-1} - 0 - \Delta H^\circ_{f[OH^-(aq)]}$

or $\quad \Delta H^\circ_{f[OH^-(aq)]} = -286 \text{ kJ mol}^{-1} + 57 \text{ kJ mol}^{-1}$

$$= -229 \text{ kJ mol}^{-1}$$

4.70 The reaction is

$$N_2O_4\ (g) \rightleftharpoons 2\ NO_2\ (g)$$

$$\Delta H^\circ = 2\Delta H^\circ_{f[NO_2(g)]} - \Delta H^\circ_{f[N_2O_4(g)]}$$

$$= 2 \times (33.2\ kJ\ mol^{-1}) - (9.2\ kJ\ mol^{-1})$$

$$= 57.2\ kJ\ mol^{-1}$$

For the dissociation of 1 mol of N_2O_4 (g)

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$= (57.2\ kJ\ mol^{-1}) - (298\cancel{K}) \times (4.8\ J\ \cancel{K^{-1}}\ mol^{-1})$$

$$= +\ 55.8\ kJ\ mol^{-1}$$

Since, the value of Δ G is +ve, the above reaction is not spontaneous at 298 K

4.71 $H_2\ (g) + \frac{1}{2}\ O_2(g) \rightarrow H_2\ O\ (l)$

The standard entropy change for the reaction is given by

$$\Delta S^\circ = S^\circ_{H_2O(l)} - S^\circ_{H_2(g)} + \frac{1}{2}S^\circ_{O_2(g)}$$

$$= 69.9\ JK^{-1}\ mol^{-1} - (130.7\ JK^{-1}\ mol^{-1} + \tfrac{1}{2} \times 205.1\ JK^{-1}\ mol^{-1})$$

$$= -\ 163.4\ JK^{-1}\ mol^{-1}$$

4.72 $H_2\ (g) + I_2\ (g) \rightleftharpoons 2HI(g)\ \Delta H^\circ = +\ 51.88\ kJ$

In this case $\Delta H^\circ = +\ 51.88\ kJ = 51880\ J\ mol^{-1}$

$$\Delta S^\circ = S^\circ_{products} - S^\circ_{reactants}$$

$$= 2S^\circ_{HI(g)} - S^\circ_{H_2(g)} + S^\circ_{I_2(g)}$$

$$= 2 \times (206.27\ J\ K^{-1}\ mol^{-1}) - (130.6\ J\ K^{-1}\ mol^{-1} + 116.73\ J\ K^{-1}\ mol^{-1})$$

$$= 412.54\ J\ K^{-1}\ mol^{-1} - 247.33\ J\ K^{-1}\ mol^{-1}$$

$$= 165.21\ J\ K^{-1}\ mol^{-1}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$= 51880\ J\ mol^{-1} - (298\cancel{K}) \times (165.21\ J\ \cancel{K^{-1}}\ mol^{-1})$$

$$= 2647.42\ J\ mol^{-1}$$

$$\Delta G^\circ = -\ RT\ ln\ K = -2.303\ RT\ log\ K$$

$$\text{or } log\ K = -\frac{\Delta G^\circ}{2.303\ RT}$$

$$= -\frac{2467.42\ \cancel{J}\ \cancel{mol^{-1}}}{2.303 \times 8.314\ \cancel{J}\cancel{K^{-1}}\ \cancel{mol^{-1}} \times 298\cancel{K}}$$

$$= -\ \bar{1}.5375$$

Equilibrium constant K = 0.3447

UNIT 5

5.60 Equivalent mass of $Cu^{2+} = \frac{63.5}{2}$ g = 31.75 g

Thus, according to Faraday's law 31.75 g of Cu is deposited when 96500 coulombs of current is passed.

∴ 1g of Cu is deposited by $\frac{1\cancel{g} \times 96500}{31.75\cancel{g}}$ C = 3039.4 coulombs. But charge in

$$\text{coulombs} = \text{current in amperes} \times \text{time in seconds}$$

$$\therefore \quad \text{current in amperes} = \frac{3039.4\,\text{C}}{(2 \times 60 \times 60)\,\text{s}} = 0.422 \text{ ampere}$$

5.61 $$\text{conductivity} = \frac{\text{cell constant}}{\text{resistance}}$$

$$\begin{aligned}\text{cell constant} &= \text{conductivity} \times \text{resistance}\\ &= 92\ \cancel{\text{ohm}^{-1}}\ \text{cm}^{-1} \times 247.8\ \cancel{\text{ohm}}\\ &= 22797.6\ \text{cm}^{-1}\end{aligned}$$

5.62 According to Kohlrausch's law

$$\lambda^{\infty}_{m}\ (NH_4OH) = \lambda^{\infty}\ (NH_4+) + \lambda^{\infty}\ (OH^-) \quad \text{eqn } 1$$

$$\lambda^{\infty}_{m}\ (NH_4Cl) = \lambda^{\infty}\ (NH_4+) + \lambda^{\infty}(Cl^-) \quad \text{eqn } 2$$

$$\lambda^{\infty}_{m}\ (NaOH) = \lambda^{\infty}\ (Na^+) + \lambda^{\infty}(OH^-) \quad \text{eqn } 3$$

$$\lambda^{\infty}_{m}\ (NaCl) = \lambda^{\infty}\ (Na^+) + \lambda^{\infty}\ (Cl^-) \quad \text{eqn } 4$$

Adding eqns. (2) and (3) and substracting eqn. (4)

we get, $\lambda^{\infty}_{m}\ (NH_4\ Cl) + \lambda^{\infty}_{m}\ (NaOH) - \lambda^{\infty}_{m}\ (NaCl)$

$$= \lambda^{\infty}\ (NH_4^+) + \lambda^{\infty}\ (OH^-)$$

using eqn. (1), R.H.S $= \lambda^{\infty}_{m}\ (NH_4OH)$

$$\begin{aligned}\therefore\ \lambda^{\infty}_{m}\ (NH_4OH) &= \lambda^{\infty}_{m}\ (NH_4\ Cl) + \lambda^{\infty}_{m}\ (NaOH) - \lambda^{\infty}_{m}\ (NaCl)\\ &= (150 + 248.1 - 126.4)\ \text{S cm}^2\ \text{mol}^{-1}\\ &= 271.7\ \text{S cm}^2\ \text{mol}^{-1}\end{aligned}$$

5.63 Molar conductivity of an electrolyte in an aqueous solution is related to its degree of dissociation (α_c) by the following equation:

$$\alpha_c = \frac{\lambda^{c}_{m}}{\lambda^{\infty}_{m}}$$

where, λ^c and λ^{∞}_{m} are the molar conductivity values of the electrolyte at concentration c mol/dm³ and at infinite dilution, respectively.

$$\text{By definition, } \lambda_m^c = \frac{\text{conductivity}}{\text{conc. in mol/dm}^3} = \frac{1.65 \times 10^{-4}\ \text{S cm}^{-1}}{0.01\ \text{mol/dm}^3}$$

$$= 10^{-4} \times \frac{1.65\ \text{S}\,\cancel{\text{cm}^{-1}} \times 10^3\,\cancel{\text{cm}^3}}{0.01\ \text{mol}} = 16.5\ \text{S cm}^2\text{mol}^{-1}$$

$$\text{(a)}\quad \text{(at 0.01M) } \alpha_c = \frac{\lambda_m^c}{\lambda_m^\infty} = \frac{16.5\,\cancel{\text{S}}\,\cancel{\text{cm}^2}\,\cancel{\text{mol}^{-1}}}{390.6\,\cancel{\text{S}}\,\cancel{\text{cm}^2}\,\cancel{\text{mol}^{-1}}} = 0.042$$

$$\text{Since, } K_{\text{dissociation}} = \frac{c\alpha^2}{1-\alpha}$$

$$\text{(b)}\quad \therefore K_{\text{diss}} = \frac{0.01\ \frac{\text{mol}}{\text{dm}^3} \times (0.042)^2}{1-0.042} = 1.83 \times 10^{-5}$$

5.64 $E^\circ \text{ cell} = E^\circ_{\text{right electrode}} - E^\circ_{\text{left electrode}}$

Thus $E^\circ_{\text{cell}} = E^\circ_{\text{Pt,H}_2(g)|\text{H}^+(aq)} - E^\circ_{\text{Cd(s)}|\text{Cd}^{2+}(aq)} = +0.40\text{V}$

Since, the right electrode of the given cell is the standard hydrogen electrode, where electrode potential is zero by convention,

$$\therefore E^\circ_{\text{cell}} = 0 - E^\circ_{\text{Cd(s)}|\text{Cd}^{2+}(aq)} = +0.40\text{ V}$$

$$\text{or } E^\circ_{\text{Cd(s)}|\text{Cd}^{2+}(aq)} = -0.40\text{ V}$$

Similarly, for the cell Zn (s) | Zn^{2+} (aq) || Cd^{2+} (aq) | Cd (s)

$E^\circ_{\text{cell}} = E^\circ_{\text{Cd/Cd}^{2+}} - E^\circ_{\text{Zn/Zn}^{2+}} = +0.36\text{V}$

or 0.36V = – 0.40 – $E^\circ_{\text{Zn/Zn}^{2+}}$

Hence, $E^\circ_{\text{Zn/Zn}^{2+}} = -0.40\text{V} - 0.36\text{V} = -0.76\text{V}$

5.65 For the cell

Ca (s) | Ca^{2+} (aq, c = 0.02 M) || Cu^{2+} (aq, c = 0.01M | Cu (s)

cell reaction is made up of the half reactions :

$\text{Ca (s)} \rightarrow \text{Ca}^{2+}\text{ (aq)} + 2e^-$

and $\text{Cu}^{2+}\text{ (aq)} + 2e^- \rightarrow \text{Cu (s)}$

∴ cell reaction is $\text{Ca (s)} + \text{Cu}^{2+}\text{ (aq)} \rightarrow \text{Ca}^{2+}\text{ (aq)} + \text{Cu (s)}$

applying the Nernst equation.

$$E_{\text{cell}} = E^\circ_{\text{cell}} + \frac{RT}{2F} \ln \frac{[\text{Cu}^{2+}][\text{Ca}]}{[\text{Ca}^{2+}][\text{Cu}]}$$

Since, [Ca] and [Cu] are taken as unity by convention.

$$E_{cell} = \left[E^{o}_{Cu(s)|Cu^{2+}(aq)} - E^{o}_{Ca(s)|Ca^{2+}(aq)} \right] + \frac{0.059\ V}{2} \log \frac{Cu^{2+}}{Ca^{2+}}$$

$$= 0.34V - (-2\ .87V) + \frac{0.0592\ V}{2} \log \frac{0.01\ M}{0.02\ M}$$

$$= 3.21V + 0.0296V \times (-\ 0.3010)$$

$$= 3.21V - 8.9 \times 10^{-3}\ V$$

$$= 3.2V$$

5.66 $E^{\circ}_{cell} = E^{\circ}_{pt,\ H_2(g)} \mid H^{+}(aq) - E^{\circ}_{Cd(s)} \mid Cd^{2+}(aq)$

$E^{\circ}_{pt,\ H_2(g)} \mid H^{+}(aq) = 0$ (by convention)

We can find $E^{o}_{Cd(s)|Cd^{2+}(aq)}$ from the following cell ·

$Zn(s) \mid Zn^{2+}(aq) \mid\mid Cd^{2+}(aq) \mid Cd(s)\ E^{\circ} = +\ 0.36V$

or $E^{o}_{Cd(s)|Cd^{2+}(aq)} - E^{o}_{Zn(s)|Zn^{2+}(aq)} = 0.36V$

but $E^{o}_{Zn(s)|Zn^{+}(aq)}$ is given as

$= -\ 0.76V$

therefore, $E^{o}_{Cd(s)|Cd^{2+}(aq)} - (-0.76V) = 0.36V$

or $E^{\circ}_{Cd(s)\ |\ Cd2+(aq)} = -\ 0.40V$

Thus, for the cell

$Cd(s) \mid Cd^{2+}(aq) \mid\mid H^{+}(aq) \mid H_2\ (g,\ 1atm), Pt$

$E^{o}_{cell} = 0 - E^{o}_{Cd(s)|Cd^{2+}(aq)} = 0 - (-0.40) = 0.40V.$

5.67 For $Zn(s) \mid Zn^{2+}(aq)$

the electrode reaction is

$Zn^{2+}(aq) + 2e^{-} \rightarrow Zn(s)\ E^{\circ} = -\ 0.76V$

The electrode potential for this electrode reaction is given by Nernst equation.

$$E_{Zn(s)|Zn^{2+}(c=0.20M)} = E^{o}_{Zn(s)|Zn^{2+}(c=1M)} + \frac{RT}{nF} \ln[Zn^{2+}]$$

$$= -\ 0.76V + \frac{0.0592}{2}\ V \log 0.02\ M$$

$\therefore E_{Zn(s)|Zn^{2+}(c=0\ 02M)} = -0.76V + 0.0296V\ (-1.699)$

$= -0\ 76V - 0.050V = -0.81V$

5.68 For the cell containing $AgNO_3$, the cathode half reaction is
$Ag^+ + e^- \rightarrow Ag\ (s)$

0.0198g of Ag is $\frac{\cdot 0198\cancel{g}}{108\cancel{g}\ mol^{-1}} = 1.81 \times 10^{-4}$ mol Ag.

Number of Faradays passed $= \frac{1F}{\cancel{mol}} \times 1.84 \times 10^{-4}\cancel{mol} = 1.84 \times 10^{-4}F$

Since, the 2 cells are in series, the number of Faradays passed in the second cell is also 1.84×10^{-4} F.

The cathode half reaction for the NaCl cell is

$2H_{2}0 + 2e^- \rightarrow H_2 + 2\ (OH)^-$

∴ No. of moles of H_2 is

$$\frac{1\,mol\,H_2}{2\cancel{F}} \times 1.84\ 10^{-4}\cancel{F}$$

$= 9\ 20 \times 10^{-5}$ mol

5 69 3 g of Zn $= \frac{3\cancel{g}}{65\ \cancel{g}/mol} = 0\ 046$ mol Zn

.046 mol Zn gives $\frac{2\ F}{1\ \cancel{mol}} \times 0.046\ \cancel{mol} = .092$ F.

1F = 96500 C

$\therefore .092$ F is $96500\ \frac{C}{\cancel{F}} \times .092\cancel{F} = 8878$ C

The desired current is 0.20 A, or 0 .20 C s^{-1}

∴ to pass 8878 C, the time required will be

$$\frac{8878\ \cancel{C}}{0.20\cancel{C}s^{-1}} = 4.4 \times 10^{+4}\ s$$

or 12 33 hours

5 70 Cell reaction is ·

Left (anode) : $Ni\ (s) \rightarrow Ni^{2+}(aq) + 2e^-$

Right (cathode) · $Ag^+\ (aq) + e^- \rightarrow Ag\ (s)$

Total cell reaction

$2\ Ag^+\ (aq) + Ni\ (s) \rightarrow 2Ag\ (s) + Ni^{2+}\ (aq)$

Since, n = 2

$$\begin{aligned} \text{and } G^\circ &= -\,nFE^\circ \\ \therefore\ G^\circ &= -\,2 \times 96{,}500\ \text{C}\ \ \text{mol}^{-1} \times 1.05\text{V} \\ &= -\,202650\ \text{J mol}^{-1} \\ &= -\,202.7\ \text{kJ}\ \ \text{mol}^{-1} \end{aligned}$$

5.71 $R = 176.6$ ohm

$k = 9\ 2 \times 10^{-3}\ \text{S cm}^{-1} = 9\ 2 \times 10^{-3}\ \text{ohm}^{-1}\,\text{cm}^{-1}$

$A = 4\ \text{cm}^2$

$$\text{Since, } k = \frac{1}{R}\left(\frac{\ell}{A}\right)$$

$$\begin{aligned} \ell &= k \times R \times A \\ &= (9\ 2 \times 10^{-3}\,\cancel{\text{ohm}^{-1}}\,\cancel{\text{cm}^{-1}}) \times (176.6\ \cancel{\text{ohm}}) \times (4\text{cm}^{\cancel{2}}) \\ &= 6.5\ \text{cm} \end{aligned}$$

The electrodes must have been 6 5 cm apart from each other

5 72 (a) The anode is the electrode

$$pt_{(s)}\,|\,H_{2\,(g)}\,|\,OH^-_{(aq)}$$

and the anode reaction is

$$\frac{1}{2}\ H_2(g) + OH^-(aq) \rightarrow H_2O\ (l) + e^-$$

cathode is the electrode

$$Pt(s)\ |\ H_2(g)\ \ |\ H^+(aq)$$

and the cathode reaction is

$$H^+(aq) + e^- \rightarrow \tfrac{1}{2}\ H_2(g)$$

(b) Cell reaction is (by adding anode and cathode reactions)

$$H^+\ (aq) + OH^-(aq)\ \rightarrow H_2O\ (l)$$

(c) $\Delta G^\circ = \cancel{-}\ RT\ \ln K_c = \cancel{-}\ nFE^\circ$

$$\ln K_c = \frac{nFE^\circ}{RT}$$

$$\text{or} \qquad \log K_c = \frac{nFE^\circ}{2\ 30RT} = \frac{nE^\circ}{(2.303\ RT/F))}$$

$$\begin{aligned} K_c &= \text{antilog}\left(\frac{nE^\circ}{2.303\ RT/F}\right) \\ &= \text{antilog}\left(\frac{1 \times 0.828\ \cancel{V}}{0.05916\ \cancel{V}}\right) \\ &= \text{antilog}\ (14.00) \\ &= 1 \times 10^{14} \end{aligned}$$

5.73 Conductivity k $= \dfrac{\text{cell constant}}{\text{resistance}}$

$$= \frac{0\ 48\ \text{cm}^{-1}}{4000\ \text{ohm}}$$

$$= 1.2 \times 10^{-4}\ \text{S cm}^{-1}$$

molar conductivity $\lambda^c_m = \dfrac{K}{c} = \dfrac{1.2 \times 10^{-4}\,\text{S cm}^{-1}}{0.01\ \text{mol dm}^{-3}}$

$$= \frac{1\ 2 \times 10^{-4}\,\text{S}\cancel{\text{cm}^{-1}}}{0.01 \times 10^{-3}\ \text{mol}\ \text{cm}^{\cancel{-3}}}$$

$$= 12\ \text{S cm}^2\,\text{mol}^{-1}$$

molar conductivity at infinite dilution λ^∞_m

$$\lambda^\infty_m = \lambda^\infty_{NH_4} + \lambda^\infty_{OH^-}$$

$$= (73\ 4 + 197\ 6)\ \text{S cm}^2\ \text{mol}^{-1}$$

$$= 271\ \text{S cm}^2\ \text{mol}^{-1}$$

(a) Since, $\alpha = \dfrac{\lambda^c m}{\lambda^\infty m}$ $\quad\therefore\quad$ $\alpha = \dfrac{12\ \cancel{\text{S}}\,\cancel{\text{cm}^2}\ \cancel{\text{mol}^{-1}}}{271\ \cancel{\text{S}}\,\cancel{\text{cm}^2}\ \cancel{\text{mol}^{-1}}}$

$$\doteq 0.0443$$

(b) Hence, the NH_4OH solution at this concentration would be 4.43% dissociated.

UNIT 6

6.62 $\dfrac{[A]_{\text{Run}\,2}}{[A]_{\text{Run}\,1}} = \dfrac{2\ 57 \times \cancel{10^{-2}}\ \cancel{\text{mol}\,\text{L}^{-1}}}{1.96 \times \cancel{10^{-2}}\ \cancel{\text{mol}\,\text{L}^{-1}}} = 1.31$

$$\frac{(\text{Rate})_2}{(\text{Rate})_1} = \frac{4\ 11 \times \cancel{10^{-4}}\ \cancel{\text{mol}}\ \cancel{\text{L}^{-1}}\ \cancel{\text{min}^{-1}}}{3.14 \times \cancel{10^{-4}}\ \cancel{\text{mol}}\ \cancel{\text{L}^{-1}}\ \cancel{\text{min}^{-1}}} = 1.31$$

∴ Rate and concentration of A are proportional

∴ the reaction is of first order.

(ii) $\dfrac{-\,d\,[A]}{dt} = k_1\,[A]$

$$\text{or} \quad k_1 = \frac{d\,[A]}{dt} \div A$$

$$= \frac{4.11 \times 10^{-4}\ \cancel{\text{mol}}\ \cancel{L^{-1}}\ \text{min}^{-1}}{2.57 \times 10^{-2}\ \cancel{\text{mol}}\ \cancel{L^{-1}}} = 1.60 \times 10^{-2}\ \text{min}^{-1}$$

6.63 $$\log \frac{k_2}{k_1} = \frac{E_a}{2.303\ R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\text{or} \quad E_a = \frac{2.303\ R \log\left(\frac{k_2}{k_1}\right)}{\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

$$= \frac{2.303 \times 8.31\,\text{J mol}^{-1}\,\text{K}^{-1} \log \frac{0.750\,\cancel{M^{-1}}\,\cancel{s^{-1}}}{0.0234\,\cancel{M^{-1}}\,\cancel{s^{-1}}}}{\frac{1}{673\,\text{K}} - \frac{1}{773\,\text{K}}}$$

$$= \frac{2.303 \times 8.31\,\text{J mol}^{-1}\,\cancel{K^{-1}} \log 32}{\frac{100}{673 \times 773}\cancel{K^{-1}}}$$

$$= 1.50 \times 10^{5}\ \text{J mol}^{-1}$$

6.64 For a first order reaction,

$\frac{1}{t} \log \frac{[A_0]}{[A]} = k$ where $[A_0]$ is the conc at time 0 and $[A]$ at time t

Calculating the L.H.S. of this equation for times 600s and 1200s, one gets,

$$\frac{1}{600\,s} \log \frac{0.100\ \cancel{\text{mol}}\ \cancel{L^{-1}}}{0.0603\ \cancel{\text{mol}}\ \cancel{L^{-1}}} = \frac{0.2196}{600\,s} = .000367\,s^{-1}$$

and

$$\frac{1}{1200s} \log \frac{0.100\,\cancel{\text{mol}}\,\cancel{L^{-1}}}{0.0363\,\cancel{\text{mol}}\,\cancel{L^{-1}}} = \frac{0.4401}{1200\,s} = 0.000367\,s^{-1}$$

Since, the value of k remains constant, therefore, this is a first order reaction.

6.65 (i) $$\log\left(\frac{k_2}{k_1}\right) = -\frac{E_a}{2.303\ R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\text{or}\quad \log \frac{2.40 \times 10^{-3}\ \cancel{s^{-1}}}{1.72 \times 10^{-5}\ \cancel{s^{-1}}}$$

$$= \frac{-E_a}{2.303 \times 8.314\ \text{J mol}^{-1}\text{K}^{-1}} \left(\frac{1}{338} - \frac{1}{298}\right) \text{K}^{-1}$$

$$\text{or}\quad \log 139.5 = \frac{E_a}{2.303 \times 8.314\ \text{J mol}^{-1}\cancel{\text{K}^{-1}}} \times \frac{40\,\cancel{\text{K}^{-1}}}{338 \times 298}$$

$$\text{or}\quad E_a = \frac{2.1446 \times 2.303 \times 8.314 \times 338 \times 298}{40}\ \text{J mol}^{-1}$$

$E_a = 103.4$ kJ mol^{-1}

(ii) $$\log \frac{k}{A} = -\frac{E_a}{2.303\ RT}$$

$$\text{or}\quad \log \frac{1.72 \times 10^{-5}\ \text{s}^{-1}}{A}$$

$$= -\frac{-103400\,\cancel{\text{J mol}^{-1}}}{2.303 \times 8.314 \times \cancel{\text{J K}^{-1}\text{mol}^{-1}} \times 298\,\cancel{\text{K}}}$$

$$\text{or}\quad \log = \frac{1.72 \times 10^{-5}\ \text{s}^{-1}}{A} = -18.1121$$

$$\text{or}\quad A = 1.82 \times 10^{+13}\ \text{s}^{-1}$$

(iii) $$\log \frac{k_{318}}{1.82 \times 10^{+13}\ \text{s}^{-1}} = -\frac{103400\,\cancel{\text{J K mol}^{-1}}}{2.303 \times 8.314\,\cancel{\text{J K mol}^{-1}} \times 318}$$

$$\text{or}\quad k_{318} = 2.37 \times 10^{-4}\ \text{s}^{-1}$$

6.66 $$-\ln\left(\frac{1}{2}\right) = kt_{\frac{1}{2}}$$

$$\text{or}\quad +2.303 \log 2 = k \times 693\ \text{s}$$

$$\text{or}\quad k = \frac{2.303 \log 2}{693\ \text{s}}$$

$$\text{or}\quad k = \frac{0.693}{693\ \text{s}} = 0.001\ \text{s}^{-1}$$

$$\therefore\ t_{90\%} = \frac{2.303}{0.001\ \text{s}^{-1}} \log \frac{100}{10} = 2303\ \text{s}^{-1}$$

6.67 $\ln[A] = \ln[A_0] - kt$

when the reaction is $\frac{1}{2}$ complete, $[A] = \left[\frac{A_0}{2}\right]$ and let the corresponding time be represented as $t_{50\%}$

When the reaction is 75% complete, $[A] = \left[\frac{A_0}{4}\right]$ and let the corresponding times be represented as $t_{75\%}$

$$. \ \ln\left[\frac{Ao}{2}\right] = \ln\,[A_0] - k\,t_{50\%}$$

and $$\ln\left[\frac{Ao}{4}\right] = \ln\,[A_0] - k\,t_{75\%}$$

$$. \ \frac{t_{75\%}}{t_{50\%}} = 2$$

6.68 (i) Since, doubling time doubles the reduction process, the reduction is a first order process

(ii) $$k = \frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{10h} = 6.9 \times 10^{-2}\ h^{-1}$$

$$= \frac{6.9 \times 10^{-2}\,\cancel{h^{-1}}}{3.6 \times 10^{3}\ s\,\cancel{h^{-1}}} = 1.9 \times 10^{-5}\,s^{-1}$$

6.69 $A\ (g) \rightarrow 2B\ (g) + C\ (g)$

At the completion of the reaction, one molecule of A is replaced by 3 molecules (two of B and one of C).

(a) initial pressure of A $= \frac{270\ \text{mm g}}{3} = 90$ mm of Hg

(b) At 10 min if p is the partial pressure of A which is decomposed, then,

$$p\ \text{total} = p_A + p_B + p_C$$
$$= (90\ \text{mm of Hg} - p) + 2p + p = 176\ \text{mm of Hg}$$

or $$p = 43\ \text{mm of Hg.}$$

Hence, partial pressure of A at 10 mm would be

$$p_A = (90\text{–}43)\ \text{mm of Hg}$$
$$= 47\ \text{mm of Hg}$$

(c) For a first order reaction,

$$\ln\frac{(P_A)_0}{P_A} = k_A$$

where, (p_A) is the partial pressure of A at time 0 and p_A is that at time t (10 min).

$$.. \ k_A = \frac{1}{10 \times 60s}\,2.303 \log\frac{90}{47}$$

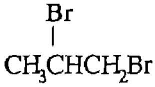
$$= 1.08 \times 10^{-3}\ s^{-1}$$

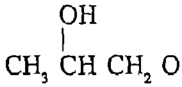
UNIT 7

7.91 (a) $(CH_3)_2\,C = CH_2 + HBr \xrightarrow{peroxide} (CH_3)_2\,CH\,CH_2\,Br \xrightarrow[ether]{Mg}$

$(CH_3)_2\,CH\,CH_2\,Mg\,Br \xrightarrow{HCHO} (CH_3)_2\,CH\,CH_2\,CH\,OMg\,Br$

$\xrightarrow{H_2O} (CH_3)_2\,CH\,CH_2\,CH_2\,OH + Mg\,(OH)\,Br$

(b) $CH_3C{\equiv}CH \xrightarrow[catalyst]{hydrogenation} CH_3CH = CH_2 \xrightarrow{Br_2}$  $CH_3\underset{}{\overset{Br}{\overset{|}{C}}}HCH_2Br$

$\xrightarrow[NaOH]{hydrolysis}$  $CH_3\,\overset{OH}{\overset{|}{C}}H\,CH_2\,OH$ $+ NaBr$

(c) $CH_3\,CH = CH_2 + HBr \xrightarrow{Peroxide} CH_3\,CH_2\,CH_2\,Br \xrightarrow{NaOH}$
$CH_3\,CH_2\,CH_2\,OH + Na\,Br$

(d) $C_6H_6 \xrightarrow[H_2SO_4]{conc.} C_6H_5(SO_3H) \xrightarrow[fusion]{NaOH} C_6H_5ONa \xrightarrow{H^+} C_6H_5OH$

$\xrightarrow{(CH_3CO_2)O} C_6H_5(OCOCH_3)$

7.92 $\underset{A}{(CH_3)_2\,C = CH_2} \xrightarrow[Zn\ dust]{ozonolysis} \underset{B}{CH_3\,CO\,CH_3} + \underset{C}{CH_2O}$

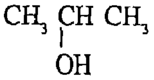
$B \xrightarrow{LiAlH_4} \underset{D}{CH_3\,CH\,(OH)\,CH_3}$

A is 2–methylpropene
B is propanone
C is methanal
D is 2-propanol

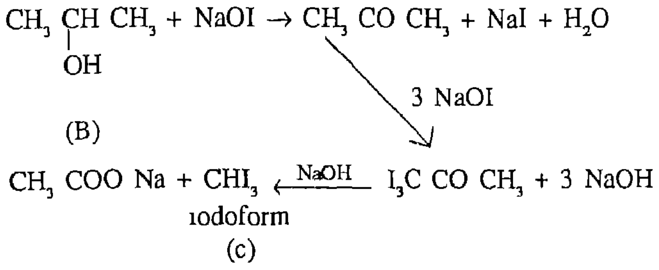
$D \xrightarrow{I_2 + NaOH} CHI_3$ (iodoform test)

7.93 (a) A is $CH_3\,CH_2\,CH_2\,OH$

$2\,Na + 2CH_3\,CH_2\,CH_2\,OH \rightarrow 2\,CH_3\,CH_2\,CH_2\,ONa + H_2$

(b) B is  $CH_3\,\underset{OH}{\underset{|}{C}}H\,CH_3$

C is CHI_3 (iodoform)



$$CH_3\underset{\underset{\displaystyle OH}{|}}{C}H\,CH_3 + NaOI \rightarrow CH_3\,CO\,CH_3 + NaI + H_2O$$

(B)

$$CH_3\,CO\,CH_3 \xrightarrow{3\,NaOI} I_3C\,CO\,CH_3 + 3\,NaOH$$

$$CH_3\,COO\,Na + \underset{\underset{(c)}{\text{iodoform}}}{CHI_3} \xleftarrow{NaOH} I_3C\,CO\,CH_3 + 3\,NaOH$$

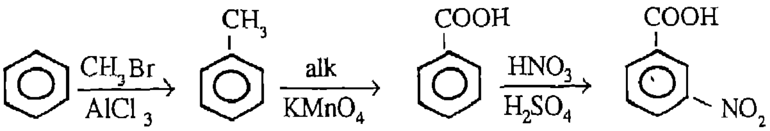
(c) D is $CHCl_3$

$CHCl_3 + C_2H_5NH_2 + 3KOH \rightarrow C_2H_5N \equiv C + 3KCl + 3H_2O$

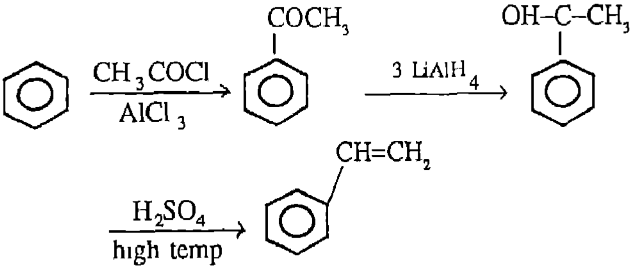
IUPAC nomenclature of D is trichloromethane.

UNIT 8

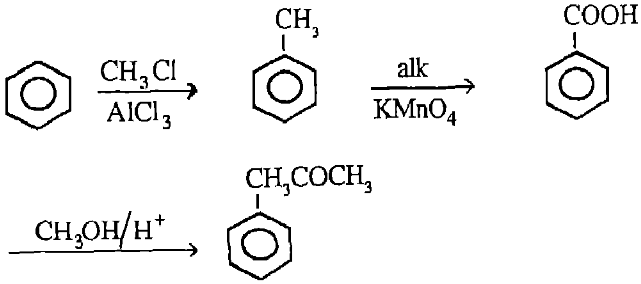
8.73 (a)



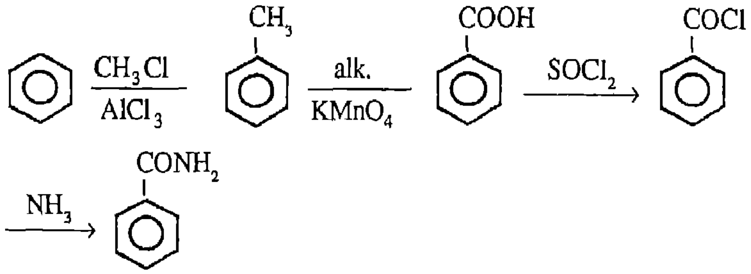
(b)



(c)



(d)



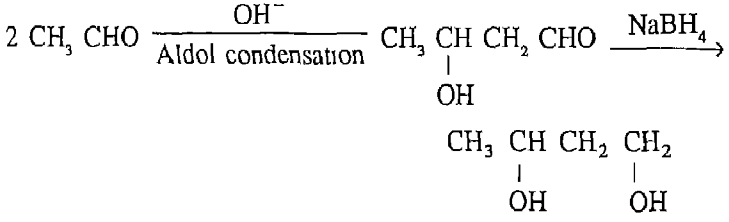
(e) $(CH_3)_2\ CH\ CH_2\ Br \xrightarrow{Mg} (CH_3)_2\ CH\ CH_2\ MgBr$

$\xrightarrow[\text{(ii) } H^+]{\text{(i) } CO_2} (CH_3)_2\ CH\ CH_2\ COOH \xrightarrow{PCl_5}$

$(CH_3)_2CHCH_2COCl$

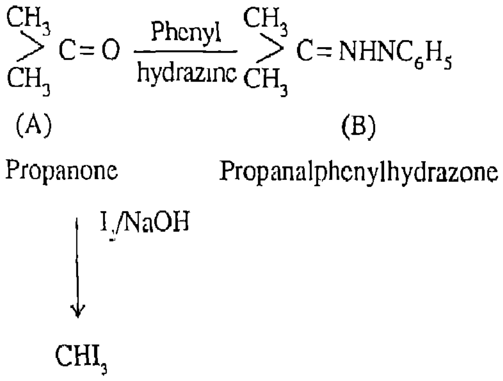
$\xrightarrow[\text{Reduction}]{\text{Rosenmund}} (CH_3)_2\ CH\ CH_2\ CHO$

(f)



$$2\ CH_3\ CHO \xrightarrow[\text{Aldol condensation}]{OH^-} CH_3\ \underset{\large OH}{\underset{|}{CH}}\ CH_2\ CHO \xrightarrow{NaBH_4} CH_3\ \underset{\large OH}{\underset{|}{CH}}\ CH_2\ \underset{\large OH}{\underset{|}{CH_2}}$$

8.74



$$\begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>C=O \xrightarrow[\text{hydrazine}]{\text{Phenyl}} \begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!>C=NHNC_6H_5$$

(A) (B)

Propanone Propanalphenylhydrazone

$\downarrow I_2/NaOH$

CHI_3

(C)

(Yellow)

Triiodomethane

8.75 $$\underset{\text{(A)}}{2HCHO} \xrightarrow[\text{Cannizarro reaction}]{NaOH} \underset{\text{(B)}}{CH_3OH} + \underset{\text{(C)}}{HCOONa}$$

Methanal Methanol Sodium methanoate

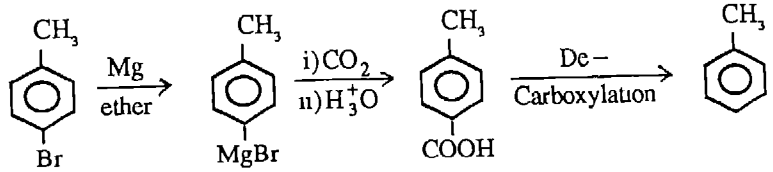
$$\underset{\text{(B)}}{CH_3OH} \xrightarrow{\text{Cu/heat}} \underset{\text{(A)}}{HCHO}$$

$$\underset{\text{(C)}}{HCOONa} \xrightarrow{H^+} \underset{\text{(D)}}{HCOOH}$$

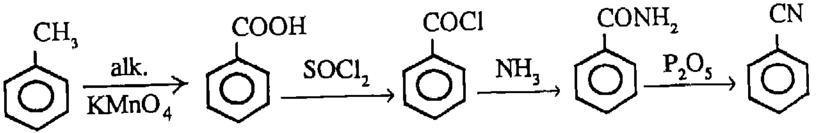
Methanoic acid

UNIT 9

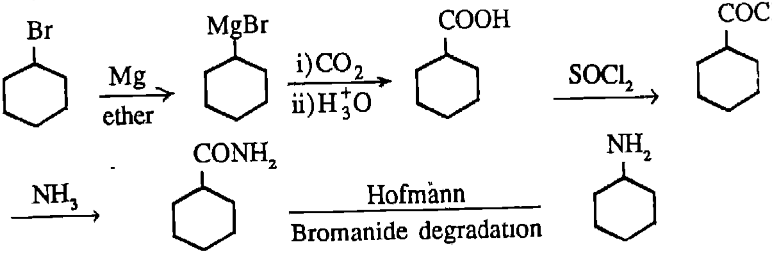
9.57 (a)



(b)



(c)

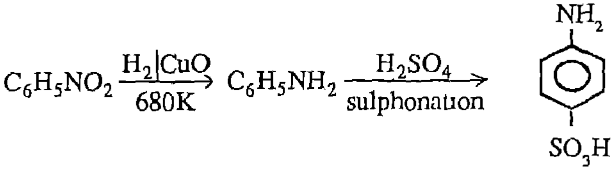


9.58 $$\underset{\substack{\text{(A)}\\ \text{chloroethene}}}{CH_2=CHCl} \xrightarrow{AgCN} \underset{\text{(major)}}{CH_2=CHNC} + \underset{\text{(minor)}}{H_2C=CHCN} \xrightarrow{H_2} \underset{\substack{\text{(B)}\\ \text{propylamine}}}{CH_3CH_2CH_2NH_2}$$

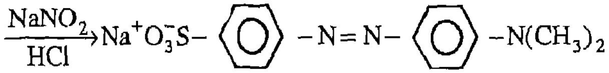
9.59 $HONO_2 + H_2SO_4 \rightarrow H_2O^+NO_2 + HSO_4^-$

$H_2O^+NO_2 \rightarrow \overset{+}{N}O_2 + H_2O$

$C_6H_6 + NO_2 \rightarrow C_6H_5\,NO_2$ (A)



nitrobenzene (A) benzenamine (B) 4-Aminobenzenesulphonic acid



methyl orange
(c)

9.60 $CH_3I + KCN \rightarrow CH_3CN \xrightarrow[LiAlH_4]{\text{reduction}}$

(A)
ethanenitrile

$CH_3CH_2NH_2 \xrightarrow{CuCl_2} [Cu(CH_3CH_2NH_2)_4]^{2+}$
Complex (C)

ethanamine
(B)

UNIT 13

13.33 $$\lambda = \frac{2.303}{t} \log \frac{No}{N}$$

$$= \frac{2\ 303}{42 \text{ days}} \log \frac{4\cancel{000 \text{ counts min}}}{1\cancel{000 \text{ counts min}}}$$

$$= \frac{2.303}{42 \text{ days}} \log 4 = 0.033 \text{ day}^{-1}$$

13.34 $$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$$

or $$\lambda = \frac{0\ 693}{t_{\frac{1}{2}}} = \frac{0.693}{14.8\,h}$$

$$\text{Now} \quad t = \frac{2.303}{\lambda} \log \frac{No}{N}$$

$$= \frac{2.303 \times 14\ 8}{0.693} \log \frac{100}{90} h$$

$$= \frac{2.303}{0.693} \times 14\ 8 \times \log 1.11 h$$

$$= 2.22 h$$

13.35 $$\lambda = \frac{0\ 693}{t_{\frac{1}{2}}} = \frac{0.693}{5760 \text{ years}}$$

$$t = \frac{2.303 \times 5760}{0\ 693} \log \frac{100}{8} \text{ years}$$

$$= 20996 \text{ years}$$

13.36 $$\lambda = \frac{0\,693}{t_{\frac{1}{2}}} = \frac{0.693}{1h}$$

If x is the amount left at 5 p.m.

$$\text{then } \lambda = \frac{2\ 303}{8} \log \frac{0.32}{x}$$

$$\text{or } \log \frac{0\ 32}{x} = \frac{8 \times 0\ 693}{2.303} = 2.4$$

$$\frac{0.32}{x} = \text{antilog of } 2.4$$

$$x = \frac{0\ 32}{\text{antilog } 2.4} = 0.0013 g$$

13.37 $$2\,{}^{1}_{1}H + 2\,{}^{1}_{0}n \rightarrow {}^{4}_{2}He$$

mass of two protons = 2 × 1.00813 = 2.01626 amu
mass of two neutrons = 2 × 1.00897 = 2.01794 amu

---

mass of 2 protons

+ mass of 2 neutrons = 4.03420 amu
mass of Helium nucleus = 4.00380 amu

$\therefore$ loss in mass = 0.03040 amu

1 amu = 931 Mev

Hence, 0.0304 amu = 931 × 0.0304 = 28.3024 Mev

13.38 Assuming that all the ^{206}Pb present in the ore is formed by the disintegration of ^{238}U the weight of ^{238}U that has changed to ^{206}Pb is

$$\frac{238}{206} \times 0.277 \text{ g} = 0.320 \text{ g}$$

Therefore, the original weight of 238_U in the ore was 1 667 g + 0.32 g = 1.987 g

$$\text{Now } \lambda = \frac{0\ 693}{t_{\frac{1}{2}}} = \frac{0.693}{4.5 \times 10^9} \text{ years}$$

$$\text{and hence } t = \frac{2.303}{0\ 693/4.5 \times 10^9 \text{ years}} \times \log \frac{1.987}{1.667}$$

$$= \frac{2.303 \times 4.5 \times 10^9 \text{ years}}{0.693} \times \log \frac{1.987}{1\ 667}$$

$$= 1\ 14 \times 10^9 \text{ years}$$

13 39 (i) From the equation, we get

5470 kJ of energy is released when 114 g of C_8H_{18} burns

$\therefore$ 8.4×10^7 kJ of energy will be released

$$\text{when } \frac{114\text{g} \times 8.4 \times 10^7 \cancel{\text{kJ}}}{5470\cancel{\text{kJ}} \times 10^3} = 1.75 \times 10^3 \text{ kg}$$

of C_8H_{18} burns

(ii) loss in mass during the change would be

$$\frac{E}{C^2} = m = \frac{8.4 \times 10^7 \text{ kJ}}{(3 \times 10^8 \text{ m/s})^2} = \frac{8.4 \times 10^{10}\text{J}}{9 \times 10^{16} \text{m}^2/\text{s}^2}$$

$$= \frac{8.4 \times 10^{10} \text{ kg}\cancel{\text{m}^2}/\cancel{\text{s}^2}}{9 \times 10^{16} \cancel{\text{m}^2}/\cancel{\text{s}^2}}$$

$$= 0.933 \times 10^{-6} \text{ kg}$$

$$= 9.33 \times 10^{-4}\text{g}$$

UNIT 15

15 70 Plot a graph between $\log \frac{x}{m}$ and log c This should be a straight line. Slope of this line = $\frac{1}{n}$ and the intercept = log k

$k = 0\ 160$

$n = 2.32$

15 71 Since, 22400 cm^3 of H_2 at STP contain $6\ 023 \times 10^{23}$ molecules

1 36 cm^3 of H at STP i.e., the limiting volume of H_2/g of Cu contain

$$\frac{6\ 023 \times 10^{23}}{22400\ \cancel{cm^3}} \times 1\ 36\ \cancel{cm^3} \text{ molecules}$$

Since, surface area of H_2 molecule is $1\ 58 \times 10^{-15}$ cm^2, and the number of H_2 molecules adsorbed per g of Cu powder is as above,

surface area per gram of adsorbent, i.e specific surface is

$$= 1\ 53 \times 10^{-15}\ \text{cm}^2 \times \frac{6\ 023 \times 10^{23} \times 1.36}{22400}$$

$$= .055 \times 10^{+6}\ \text{cm}^2$$

$$= 5\ 5 \times 10^{+4}\ \text{cm}^2$$

Workshop on Development of Test Items in Chemistry, Class XII

(NIE Campus, 17-21 September 1990)

LIST OF PARTICIPANTS

1 Dr V N Pathak
Department of Chemistry
University of Rajasthan
Jaipur 302004

2. Dr G P Pokhariyal
Department of Chemistry
M M. College
Khekra 201101

3. Dr (Smt.) Sushmita Chowdhury
Department of Chemistry
Gargi College
New Delhi 110099

4. Dr P.N. Pathak
Regional College of Education
Shyamla Hills
Bhopal 462013

5. Dr S. Narayanan
Department of Chemistry
Deshbnandhu College
Kalkaji, New Delhi 110019

6 Dr (Smt.) Amrita T. Sheikh
Department of Chemistry
Miranda House
Delhi University
Delhi 110007

7 Sh P R Rajagopalan
PGT (Chemistry)
Mani Higher Secondary School
Coimbatore 641037

8. Dr Rajan Bandhiwar
Master in Chemistry
Sainik School
Rewa Distt 486001

9. Sh R.S. Chauhan
PGT Chemistry
Kendriya Vidyalaya
Lawrence Road
Delhi 110035

10. Dr S K Mahapatra
Regional College of Education
Bhubaneswar 751007

11. Dr A.K. Kaushal
Principal
Shiksha Bharati Public School
Palam, New Delhi 110045

12. Dr S.C. Sharma
Department of Chemistry
Khalsa College
Delhi 110007

13 Dr Vinod Kumar
Hansraj College
Department of Chemistry
Delhi 110007

14 Prof. Puran Chand
Regional College of Education
Ajmer 305001

15 Shri R S. Krishnan
Principal
Kendriya Vidyalaya, Nahara
Distt. Sonepat
Haryana 131001

16 Dr H.B. Singh
Department of Chemistry
Delhi University
Delhi 110007

17 Smt. Sumitra Yadav
Senior Teacher
Navyug School
Sarojini Nagar
New Delhi 110023

18 Smt. Kiran Angra
Lecturer in Chemistry
Hindu Girls College
Sonepat 131001

19. Shri P.N Ahuja
PGT (Chemistry)
Kendriya Vidyalaya
Sadar Bazar
Delhi Cantt. 110010

20. Dr (Smt.) Rita Kakkar
St Francis College
Begumpet
Hyderabad 500016

NCERT Faculty Members

1 Prof M. Chandra *(Coordinator)*
2. Prof R.D. Shukla
3 Dr V N.P. Srivastava
4 Dr Brahm Prakash
5. Dr M. Mansoor
6. Dr (Smt) S.B. Mallik
7. Dr (Smt) Kamlesh Mittal
8. Dr (Smt.) Jaishree Sharma

Workshop on Development of Test Items in Chemistry, Class XII

(NIE Campus, 19-23 August 1991)

LIST OF PARTICIPANTS

1 Prof. J.C. Ahluwalia
Department of Chemistry
I.I T.
Hauz Khas
New Delhi 110016

2 Prof B L Khandelwal
Department of Chemistry
I.I.T.
Hauz Khas
New Delhi 110016

3. Prof. C S Pande
Department of Chemistry
Himachal Pradesh University
Summer Hill
Himachal Pradesh 171005

4 Prof A.N. Bose
Professor of Chemistry (Retd)
99, Shivalik Apartments
Alaknanda
New Delhi 110019

5. Prof. S.P Mishra
Department of Chemistry
B.H U.
Varanasi 221005

6 Dr R.N. Maini
Department of Chemistry
St. Stephen's College
Delhi University
Delhi 110007

7 Dr Kiran Kapoor
Department of Chemistry
Miranda House
Delhi University
Delhi 110007

8 Dr Shashi Saxena
Department of Chemistry
Hansraj College
Delhi University
Delhi 110007

9 Dr Lakshmi
Department of Chemistry
Gorakhpur University
Gorakhpur 273009

10. Dr Vijay Sarda
Department of Chemistry
Zakir Hussain College
Delhi University
New Delhi 110002

11. Dr A.K Singh
Department of Chemistry
I.I.T
Hauz Khas
New Delhi 110016

12. Dr R.K. Bansal
Department of Chemistry
I.I T.
Hauz Khas
New Delhi 110016

13. Dr K N Java
Department of Chemistry
S G.T.B. Khalsa College
University of Delhi
Delhi 110007

14. Dr S Bhanumati
Department of Chemistry
Gargi College, University of Delhi
Siri Fort Road
New Delhi 110049

15. Dr V.K. Rohatgi
Department of Chemistry
Kirori Mal College
University of Delhi
Delhi 110007

16 Dr K. L. Kapoor
Department of Chemistry
Hindu College
University of Delhi
Delhi 110007

17. Dr A.K. Tripathi
LIG Flats, J.C. 36/B
Mayapuri
New Delhi

NCERT Faculty Members

1 Prof. M. Chandra *(Coordinator)*
2. Prof. R.D Shukla
3. Dr V.N P. Srivastava
4. Dr Brahm Prakash
5. Dr M. Mansoor
6. Dr (Smt.) Jaishree Sharma